Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

MARCH 1949

in

SIZING

the

TREND

is

to

AUTOMATIC

EMULSIFYING

A significant advance in rosin size technology is the development of the new Hercules Automatic Emulsifying Process.* Completely automatic, it converts Hercules Paste Rosin Size into a dilute emulsion. The new process saves considerable labor, eliminates the necessity for large storage tanks, requires a minimum of space. Easy to install, it also permits the use of certain types of sizes which could not previously be used because of inadequate emulsion stability. Many mills are adapting this process to their papermaking economy. Write for our new booklet

HERCULES POWDER COMPANY

INCORPORATED

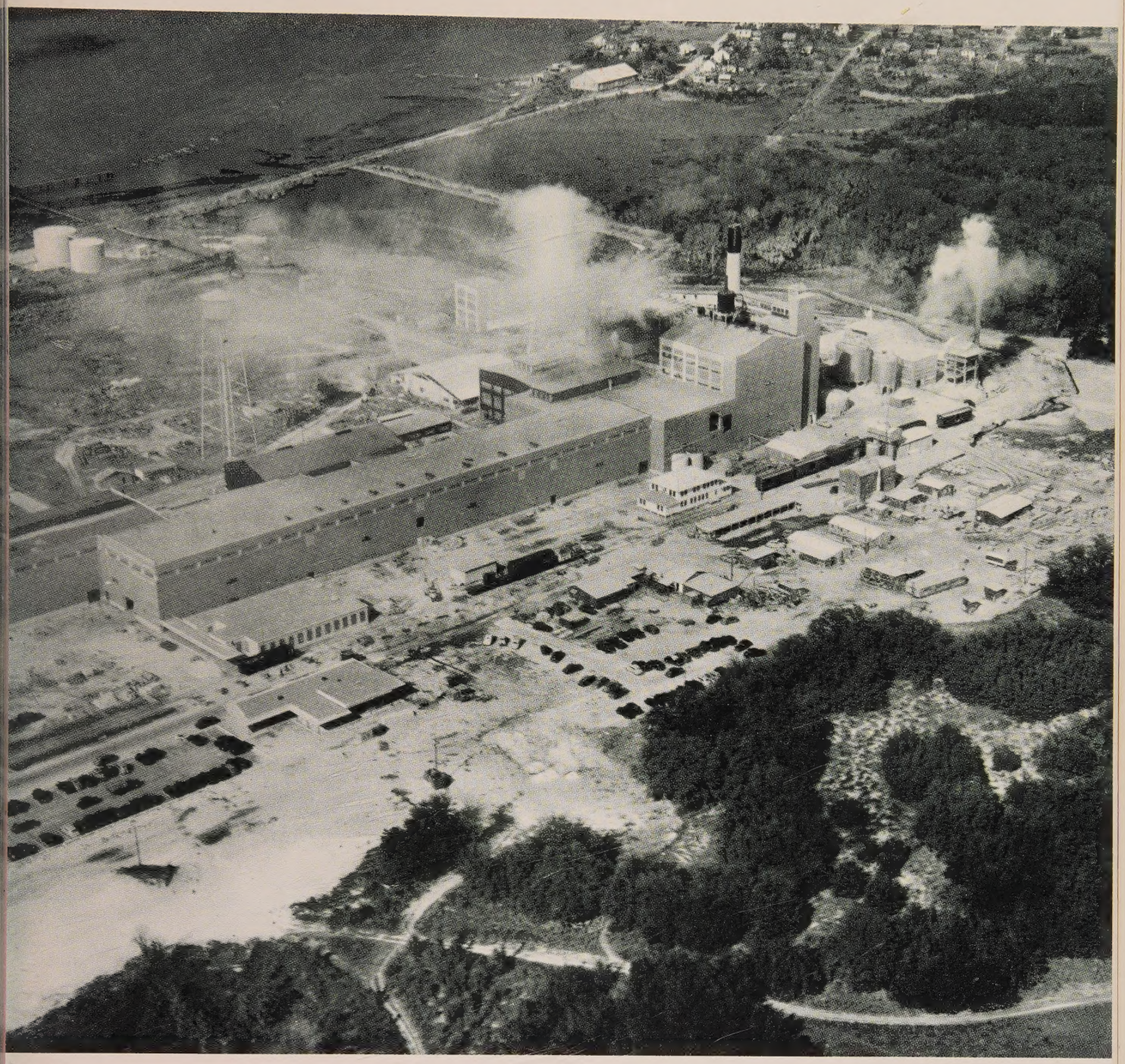
SIZING MATERIALS AND CHEMICALS FOR PAPER

967 King Street, Wilmington 99, Delaware

*PATENT APPLIED FOR

PP9-3

Container: kraft pulp and board



Container Corporation of America, at Fernandina, Florida, operates one of the industry's outstanding modern pulp and board producing plants. Location is strategic for the utilization of Southern slash pine. Layout is planned to provide smooth, efficient, economical flow of material from pulp wood to finished board. Equipment includes a Beloit 136″ Fourdrinier machine, especially designed for drying pulp, and a new Beloit High Speed Fourdrinier Kraft machine, put into production on board last year. —*Beloit Iron Works, Beloit, Wisconsin.*

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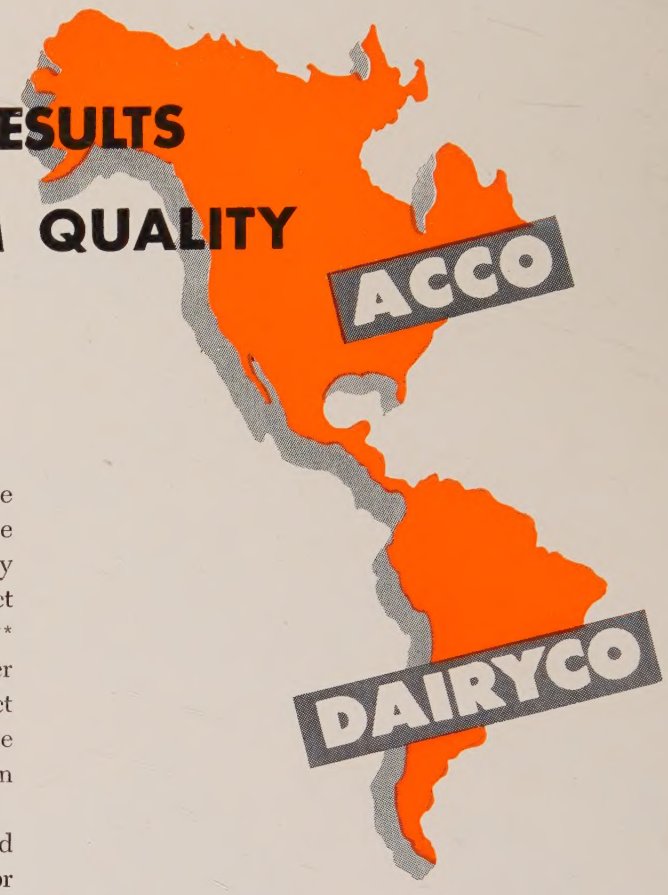
BELOIT

PAPER MACHINERY

Paper Product Pointers
FROM CYANAMID

Re: Wider Markets for Paper...

GOOD COATING RESULTS DEMAND UNIFORM QUALITY CASEIN...



In the manufacture of casein, every step in the process, from skimming the milk to packaging the finished product, must be carefully supervised. Any deviation from standards could noticeably affect quality and performance. Cyanamid's ACCO** Brand of domestic casein is manufactured under close supervision and is quality-controlled for strict uniformity. Customers are therefore assured of the finest coating agent and binder for paper when they buy ACCO Casein.

Equally high quality and uniformity are assured with DAIRYCO Brand of Argentine casein, for which Cyanamid is sole U.S. agent. In addition, Cyanamid's laboratories are constantly working on evaluation methods and improved procedures for applying casein to paper. Thus, Cyanamid is in an excellent position to meet all casein needs of any paper manufacturer: with domestic or imported casein, and with Technical Service to help solve coating problems. Consult our nearest representative about casein—or the many other Cyanamid chemicals for more efficient paper-making.

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*Reg. U. S. Pat. Off. **Trade-mark

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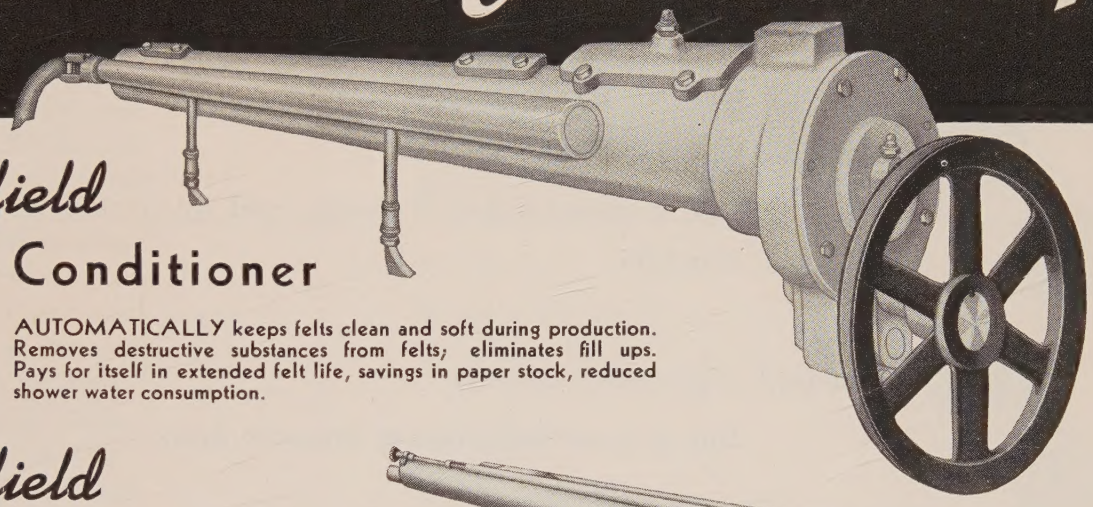
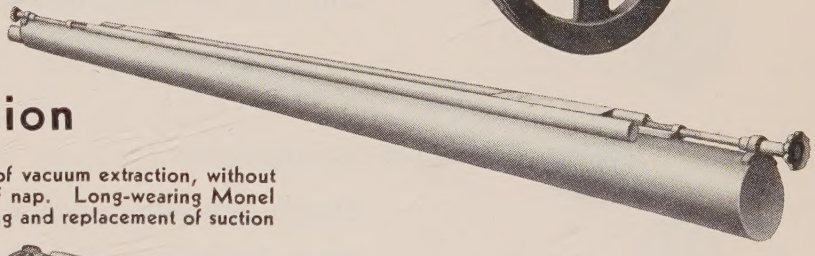
INDUSTRIAL CHEMICALS DIVISION
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Speed Up Output
Cut Costs Per Ton
Soft, Clean Felts All the Time
The Scofield Way



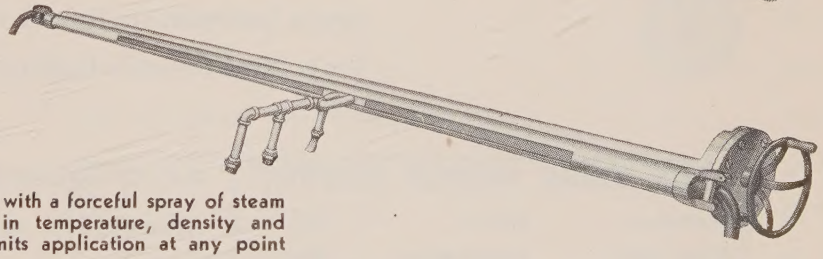
Scofield
Felt Conditioner

AUTOMATICALLY keeps felts clean and soft during production. Removes destructive substances from felts; eliminates fill ups. Pays for itself in extended felt life, savings in paper stock, reduced shower water consumption.



Scofield
Venturi Throat Suction

PRODUCES highly superior method of vacuum extraction, without pinching pull on felt or destruction of nap. Long-wearing Monel metal bars eliminate frequent resurfacing and replacement of suction box covers.



Scofield
Wire Cleaner

FLUSHES wires and cylinder moulds with a forceful spray of steam and water, accurately controllable in temperature, density and velocity. Hand wheel control permits application at any point across width of machine.

Like all Sandy Hill Products, Scofield equipment is designed and built to the highest standards of precision and quality. Let us show you how they can fit into your production and economic program.

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- Fourdrinier Paper Machines
- "Packer" Screens

- Castings
- Bleaching Equipment
- Scofield Felt Conditioners
- Cleveland Type Bearings
- Shaker Screens

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Due to great reduction of pressure drop.

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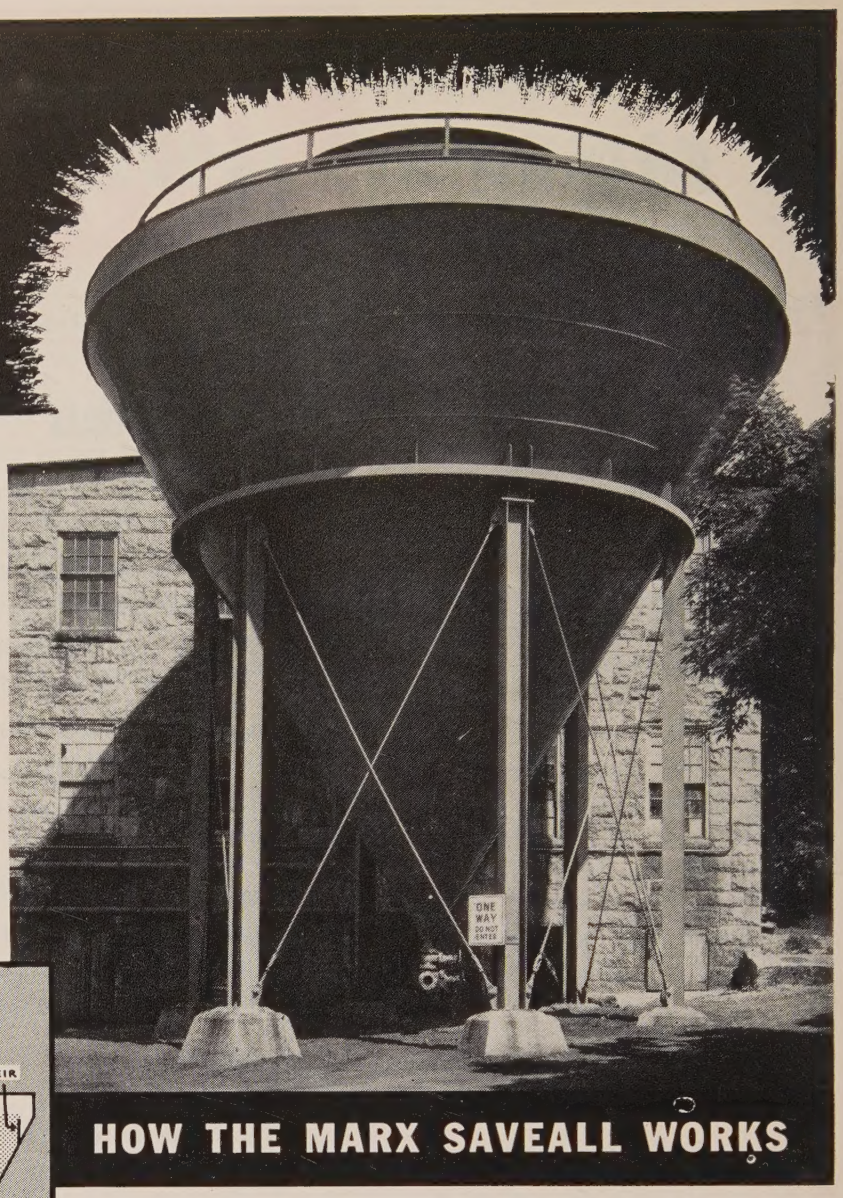
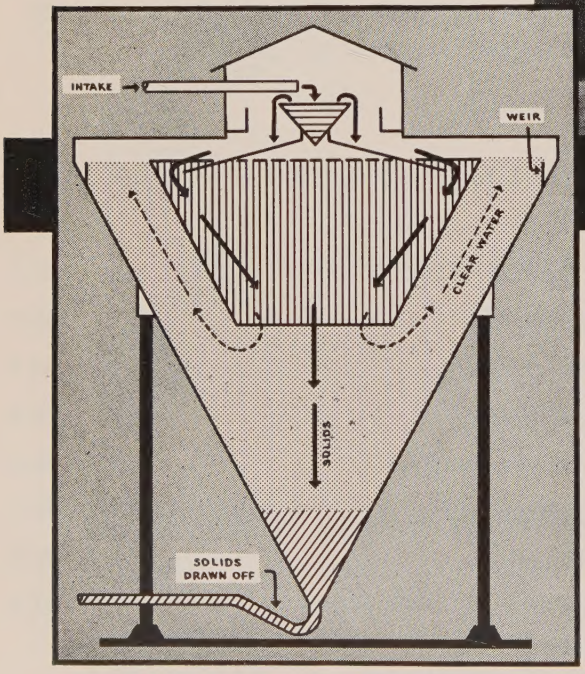
97.4%

OF FIBROUS SOLIDS REMOVED FROM WASTE WHITE WATER



The Marx Saveall shown at the right was installed at a paper boxboard mill to clarify the white water effluent from the paper machines prior to its reuse or discharge. A report on the operation of this Saveall shows that it is 97.4 per cent effective . . . reducing suspended fibrous solids in the waste water from 4.66 lbs. per 1,000 gals. to 0.10 lbs. per 1,000 gals.

The clarification process in a Marx Saveall is accomplished by settling. The diagrammatic sketch below illustrates the manner in which it operates.



Marx Savealls are typical examples of the special steel plate structures we design, fabricate and erect for pulp mills and boxboard plants. Let our engineers work with you on your next steel plate work requirements.

HOW THE MARX SAVEALL WORKS

The Marx Saveall consists primarily of two large steel plate cones, one inside the other, as shown at the left. The inner cone has a large opening at the bottom.

There is a small cone-shaped receiving well at the top and an inverted de-aeration cone directly under the receiving well. Waste white water from the paper board machines is fed into the receiving well at the top, overflows in a thin film onto the de-aeration cone (where the air bubbles are shaken loose from the solid particles) and runs off the cone's outer edge and into the center of the unit. The suspended solids settle through the bottom of the inside cone, collect in the bottom of the outside cone, and are drawn off and fed into a continuous beater for re-use. The water, minus most of the solids, rises between the two cones and overflows into a weir at the top of the outer cone. From there it is piped to storage tanks for re-use in the beater room or it is discharged into a nearby stream.

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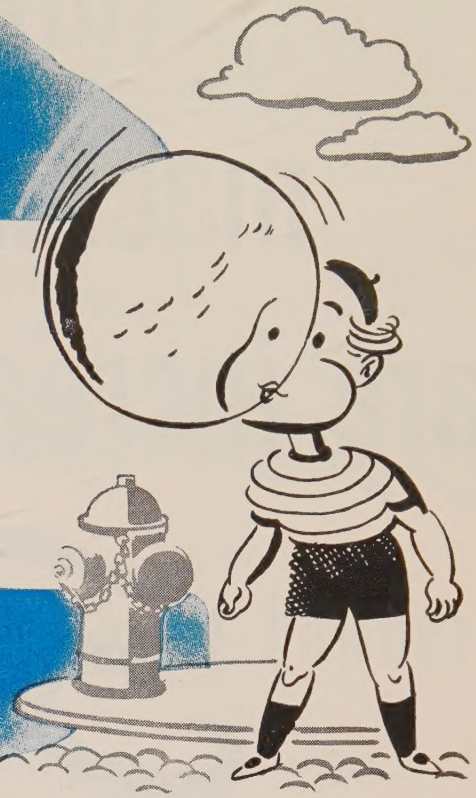

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How cylinder machine operators are increasing production

3 to 5%

from present equipment

USING only existing equipment, many paper mill men have found a practical, low-cost way to step up production of cylinder machine boards.

A small amount of Celite* added to the furnish, they find, pays dividends in faster drainage and drying . . . higher machine speeds . . . increased production.

Here are the reasons why:

During formation, Celite's porous, irregularly shaped particles help keep the fibres more uniformly dispersed, thus preventing premature agglomeration. This provides better channels for the flow of water, gives the initial mat uniform drainage. Additional stock is picked up and distributed more evenly . . . formation is improved.

As a result, the sheet drains freely with less possibility of checking or crushing at the couches. There is also less tendency to disrupt formation at the nips between rolls.

Drying is faster, because the Celite maintains a multiplicity of paths through which the water can flow, permitting more rapid transfer of moisture from the inner strata to the surface of the board.

These improvements in drainage and drying often make possible higher machine speeds. From 3 to 5% is not unusual, and increases as high as 10% have been noted in actual production runs.

A little Celite may go a long way in helping you, too, increase production from your present equipment. Why not investigate the possibility—now? For full details, write Johns-Manville, Box 290, New York 16, N. Y.

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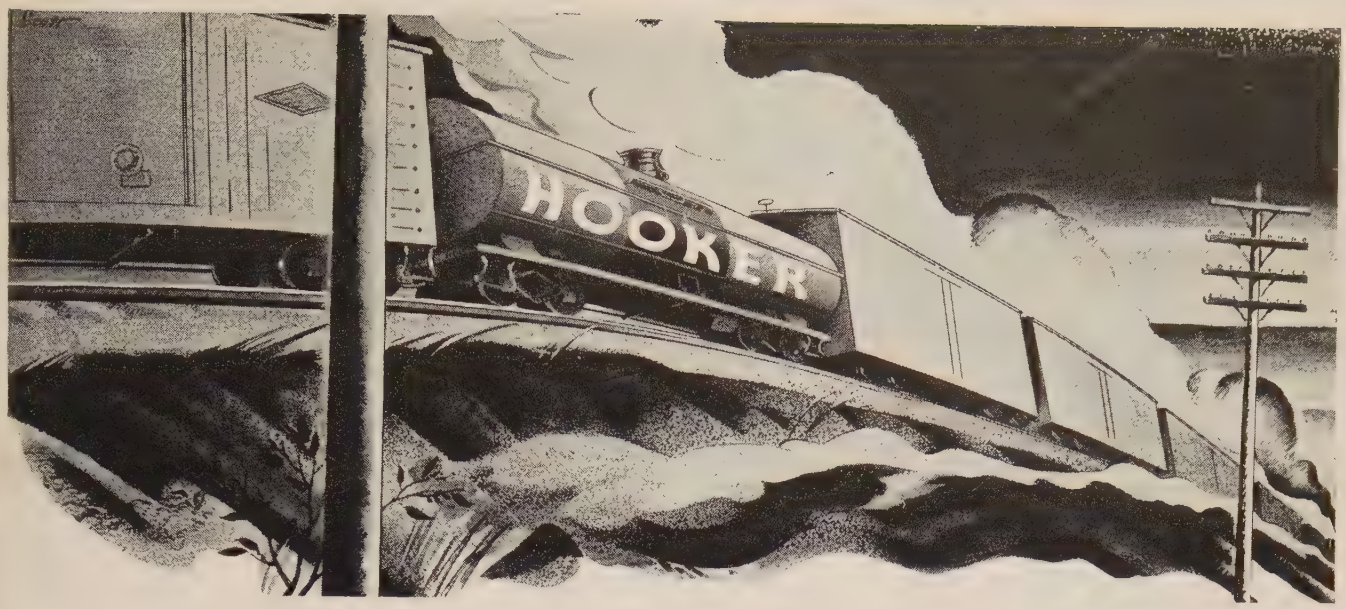

Liquid Chlorine Versus Bleaching Powder

ALTHOUGH bleaching powder was in regular use by pulp and paper makers for many years, it carried with it time consuming and costly difficulties. Bleaching powder was never stable in storage and when made into bleach liquor, it was difficult to get clear solutions and to eliminate sludge.

When liquid chlorine became readily and cheaply available, the old bleach powder methods could be discarded. Under the stimulus of production for World War I, electrolytic cell design improved, chlorine production increased and economical methods of liquifying and transporting were developed. Hooker engineers and chemists played an important part in this progress. They also helped specifically in the pulp and paper industry not only in improving bleaching techniques but in the designing of bleaching equipment.

Hooker technicians are constantly engaged in making available for you the high purity liquid chlorine and other Hooker chemicals you use. The results of their studies, too, are available in Hooker Technical Bulletins and cover a wide range of subjects of interest to pulp and paper makers. A list of the titles of these bulletins and copies of those you would like to have will be sent to you when requested on your letterhead.

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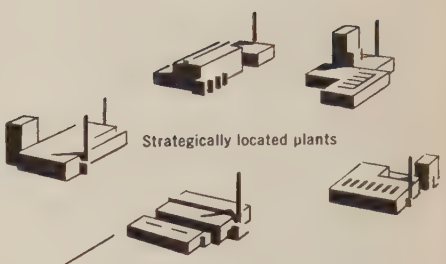

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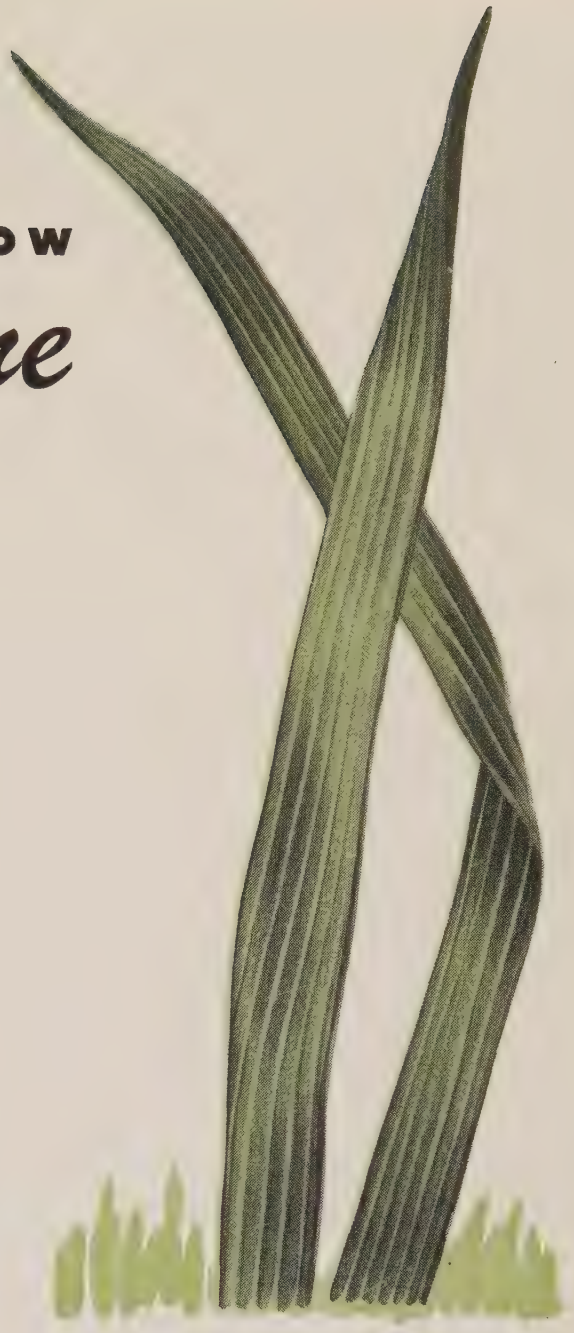
Two NOW GROW WHERE ONLY *One* GREW BEFORE . . .



Any horticulturist will tell you that one of the most difficult types of gardening is the cultivation of a lawn. It takes long and proper preparation of soil, the planting of good seed, and painstaking care after the seeds begin to grow.

We're not horticulturists, but we see the analogy in building a competent personnel in business. It's been that way with us. In the early days of Downingtown, our engineering staff was small, but carefully selected and trained. And, like the blades of grass, our engineering staff has multiplied in number. Today, after long and proper preparation, good planting of knowledge and painstaking care of sound engineering, we are better equipped than ever to fulfill your needs . . . quickly. And this "cultivated" engineering staff has the added advantage of drawing on our vast, fertile "reservoir of knowledge" built up during our 69 years of designing and building machinery for paper makers. *Another "reason why" for coming to DOWNINGTOWN.*

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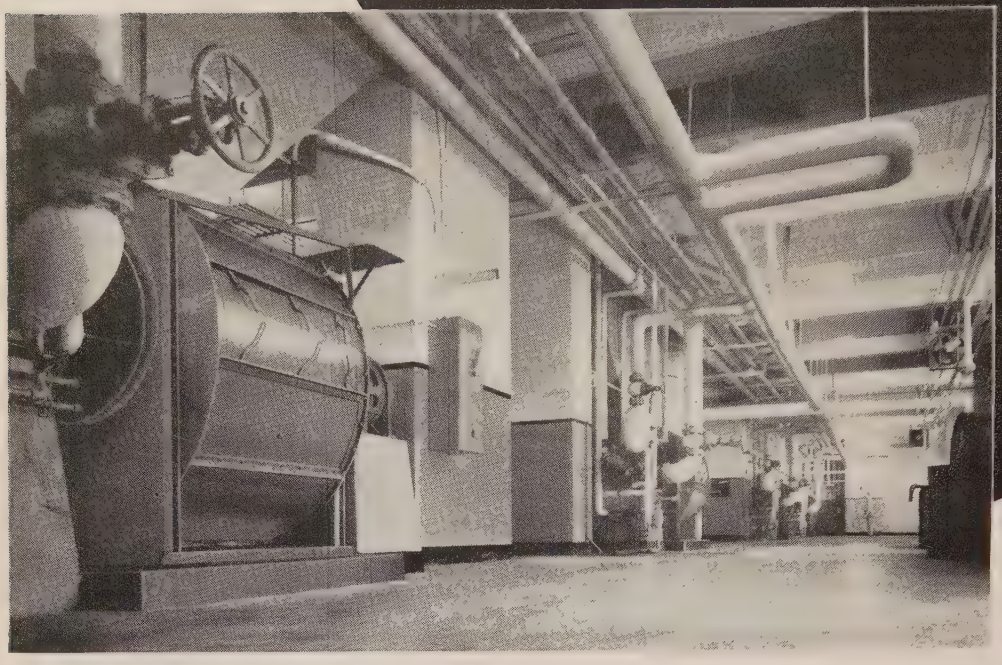

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WHY BUFFALO DRAFT FANS LAST LONGER is shown in this Bulletin No. 3113-A. Write for your free copy and get all the engineering data on construction and performance.

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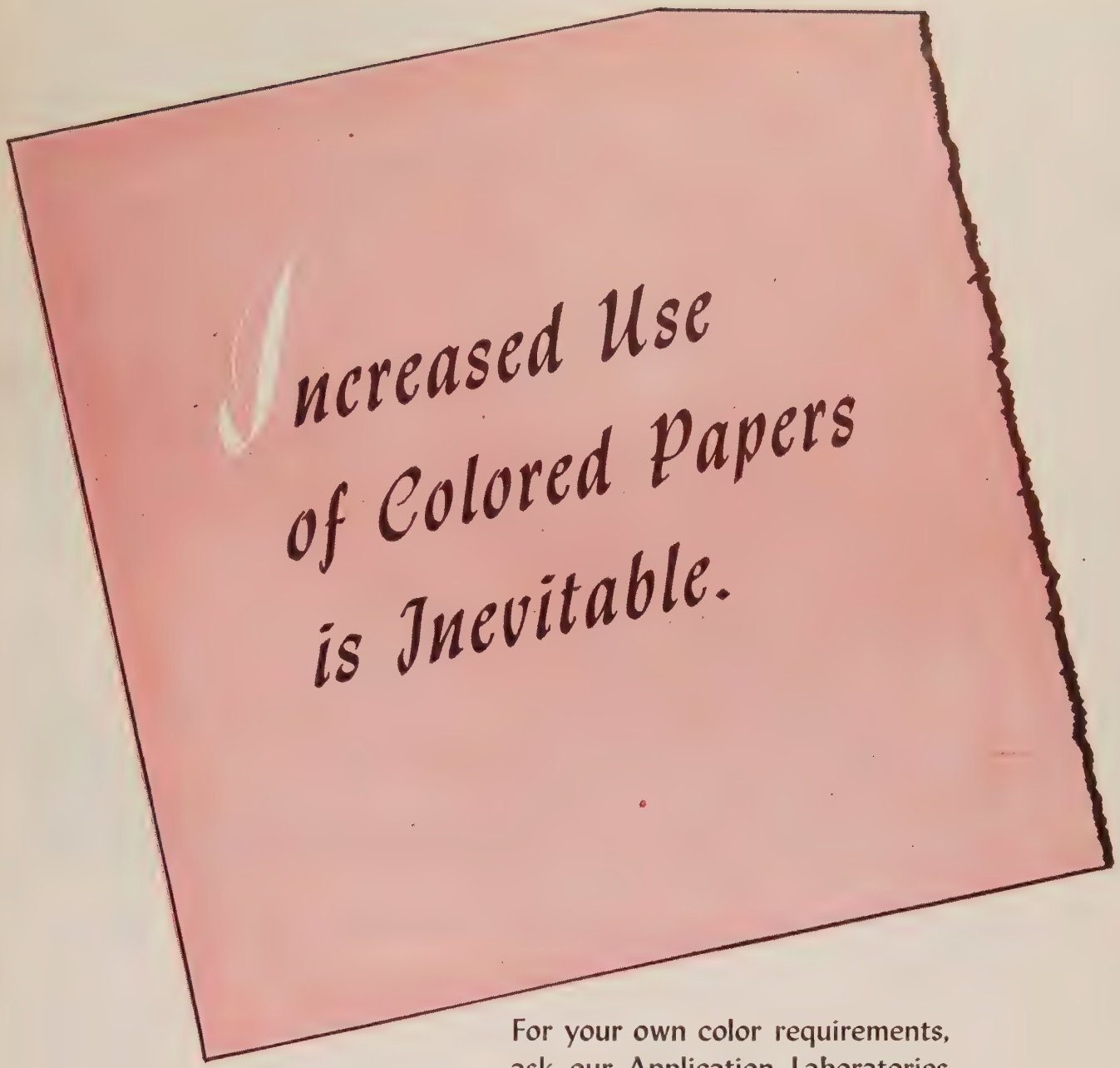

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"Big, beautiful, and busy" is the enthusiastic description of this new Beloit 165" book paper machine installed for Crown Zellerbach Corporation in West Linn, Oregon. In operation only a short time, this modern machine with air-operated controls and machine coating, is already making outstanding production records.

This new machine is equipped with Manhattan Rubber Covered Rolls. We are proud of Beloit's reliance on Manhattan rolls for the precision and quality required to maintain Crown Zellerbach's standards for high-grade book papers.

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THE PAPER INDUSTRY —as I See It*

D. Clark Everest
(President, Marathon Corp.)

Mr. Chairman, Ladies and Gentlemen:

I have been asked to say something of the problems confronting the paper and pulp industry in America. I might say I have again been asked to do this, as those were the words I used in beginning my speech at the fall meeting of TAPPI in September, 1928, a little over twenty years ago. I have been a member of your organization since June, 1915, and when I was admitted to membership it was under that section which provided that membership was extended to "persons who have special qualifications or others who are qualified by their connections to support the aims of the section." I was not eligible under the clause providing for a "technical education," but I have always been happy in the thought that I was able to get in under the "support" clause.

The objects of the Technical Section of the American Paper and Pulp Association were "to stimulate interest in the science of Pulp and papermaking; to provide for the interchange of ideas among its members, and to encourage original investigation." I think this has been accomplished, as attendance at this meeting testifies. There were relatively few members in the original group during 1915 but the growth in membership since that time has been tremendous.

No other industry, with which I am familiar, has anywhere near the number of scientists, technicians, and technically educated people connected with it, directly and indirectly, as the pulp and paper industry.

In 1928 I was reciting the list of troubles, both real and imaginary, which then seemed to confront the industry. In reviewing this speech, I find that many of the difficulties we were talking about at that time have disappeared completely and largely through the efforts of members of TAPPI. On the other hand, as we size up the situation today we find many of our problems of twenty years ago still unsolved. Probably many of them will be unsolved twenty years hence. In 1928 we were dealing with a consumption of 12.5 million tons, whereas last year our consumption of paper and paperboard was 26 million tons. Consumption has more than doubled, but your membership has increased to an even greater extent.

In order to get down to fundamentals, let us analyze the problems which seem to be the bottlenecks of the future; by so doing, we may be able to indicate the direction we should take in our future work of research and development. If one is to do a satisfactory job, he must have tools and facilities for pursuing his work. Since 1928 the industry, as a whole, has made remarkable strides in providing such facilities. As in everything else, the thing of prime importance is providing personnel capable of doing what is required. In the educational field, I believe we have the best facilities of any industry for the training of men for the specific problems we have to deal with. When you think of all the established universities and colleges available for the education of our future technical staffs and, also, the Institute of Paper Chemistry and the facilities it has to offer for advanced education and training of scientists for the pulp and paper industry, you will realize that we have an unbeatable combination which should produce ample personnel of the right type to assure the continuity of this industry.

The Institute of Paper Chemistry, which has been financed by a number of the forward-looking concerns in the industry, was the brain-child of several of the men who, in 1915, foresaw the need and were responsible for the foundation of the Technical Association of the Pulp and Paper Industry. As, in the case of the membership in your Association, the support of the Institute of Paper Chemistry has continued to expand and to include many more of the manufacturers in the industry. Greater use can and should be made of its facilities.

During the period of this Association's existence, undoubtedly spurred on by many of you in your battle to meet competitive situations, industry has spent very large sums in providing men, materials, and facilities to carry on its research programs. The industry, as a whole, is better equipped to do its research and development work than any other I know about. With this background we should be able to solve any major problem with which we are confronted.

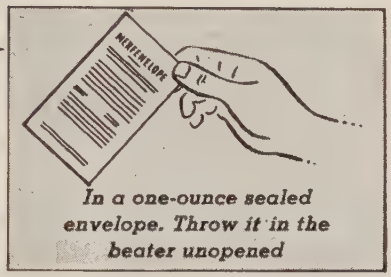
In determining bottlenecks, which in my language means the things that will give us headaches in the future in providing basic raw materials in adequate supply, the first thing which comes to mind is wood.

(*continued on page 20A*)

* An address presented at the annual luncheon of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 21-24, 1949.

Merfenelopes

FOR SLIME CONTROL



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Cleans Pipes
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(*continued from page 18A*)

If population continues to increase at the same rate it did in the last ten years and the annual consumption per capita of paper and paperboard remains the same as it was in 1948, then in 1958 we will be consuming 29,122,000 tons, or 3,000,000 tons more than we did last year, which was the all-time peak of consumption. This does not allow anything for new uses which seem bound to come about the same as they have contributed to increased consumption per capita in the past.

What, then, of our wood supply? As a common sense proposition it seems to me that we must place more emphasis on research to develop a better utilization of all species and consumption of waste in the cutting and handling of presently utilized species. It seems to be a difficult task to get people to realize that trees are a crop which eventually matures, reaches its peak value, and should be harvested at just the right time, the same as any other agricultural crop. We see stands of timber that may be ninety years old and we think of them as "virgin stands" and, in our subconscious minds, look upon them as though they had always been there. As a matter of fact, there may have been a rotation of crops of trees on that land hundreds of times in the past. Now we come along and suddenly discover that there is about so many square miles of land (which means soil) available for the growing of trees, but we find this soil will not grow any kind of tree that someone thinks he wants for his particular operation. The kind of trees he must grow depends on the kind of soil Mother Nature placed in that particular spot in the world.

We have not been too successful in combating nature and everything you do successfully is based on natural laws. Your work in research is to discover these natural laws. Our difficulty is that we are trying to find a way to meet a demand faster than we have found ways to augment the supply. This means we will have to use other species to make up for any deficiency in the species we have usually employed.

In endeavoring to secure adequate supply of wood we are combating pests, insects, and disease which, in the regular course of events, were the natural things that occurred in the rotation of crops through regeneration. There are many things we can do to overcome the difficulties we are having in a rapidly growing industry in providing adequate raw material supply.

First: We must realize that this is a long-range program and that much of our present supply is infested with bugs or infected with disease. It is estimated that the wood rendered unfit for use through insects and disease is much greater in amount than that destroyed by fire. Fire, however, is much more spectacular and gets much more publicity and money for suppression than the others do.

Our primary need is more entomologists and pathologists. If we are to preserve our wood supply we must start at the source of our trouble and, through research, extend the life of the trees now growing, the same as pathologists are doing for mankind.

The pulp and paper industry is the logical agency to start such work on a broad base. This activity might well become one of the most important sections of the Technical Association. Many of the things we do have only come about when we were pushed into them. Why not inaugurate some of these movements and anticipate shortages and also avoid the pressure of public opinion to remedy some of these situations.

Second: Let us try to get more usable material of one kind of another out of the wood we process. For years you have upset the quietude of the business administrators who think they run their own lives and the concerns they represent. There is no greater fallacy than assuming that anyone may not have all his plans upset in less time than it takes to discuss them. Things move faster and there are hundreds of you men and women who are thinking constantly of problems of the industry. Every one of you is sure to come up with some idea which, for the time being, is disconcerting to your neighbor and to management. It does not take long for innovations to become standard practice in processing or common products in commerce.

Third: I would like to comment on one thing which is brought out at regular intervals, in newspaper and scientific articles, and that is the substitution of annual plant growths, agricultural wastes, etc., for our basic raw material—wood.

Having dabbled in this field with rather disastrous results, and after careful analysis of the economics of such substitutions, I cannot get too excited about getting stuck with some woodlands on my hands. If any of you have any such ideas and are spending much time on research, it might be well to have an economist and an accountant, also, make an investigation concurrently of methods of harvesting, present utilization of wastes, freight rates, cost of collection, baling, storing, and a dozen other things which will occur to a good accountant. In this day and age, with all you smart scientists and technicians around, I am not saying that annual plant growths, etc., will not some day become a large source of our raw material. In the meantime, however, I will continue to harp on getting a larger and better supply of good old-fashioned trees.

Matthias Koops started the use of straw in paper manufacture in 1800. Celotex Corporation is doing a good job in utilizing bagasse. Another concern has successfully used licorice roots in building boards for years, but we are dealing with 26 million tons of paper and paperboard consumption and wood now seems our only important available raw material.

As I review my talk of 1928, and my reference to Professor Ralph McKee's talk in 1915, many of the things included in the list of objectives and the outline of the program seem rather elemental. In 1915 he also stressed utilization of other species and particularly referred to the fact that some mills were experimenting with the use of jackpine, tamarack, Douglas fir, and other similar woods. He thought they might have good possibilities. No one mentioned the possible use of the lowly aspen, although Dr. McKee has since done much work along the line of developing a fast-growing hybrid poplar.

Many of the other things which were mentioned in the original meeting of your Association are still the

(*continued on page 22A*)

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National
STARCH PRODUCTS

(*Continued from page 20A*)

subject of much discussion, research, and experimentation.

I cannot help but refer to the progress which has been made in breaking down the barrier that existed between the so-called practical and the technical staffs. Over the years this difficulty has been almost entirely wiped out. Everyone recognizes the necessity for highly trained personnel to cope with the problems of one of the most complex businesses in existence today.

No other business deals with such a variety of raw materials which may be used in so many ways over such widely varying types of equipment as the paper and paperboard business. The versatility of people engaged in this business in substituting one material for another, and still accomplishing the same end result in a product, is unequalled in any other line of manufacture. Such an opportunity is always a challenge to you and to all others connected with an industry.

Getting into the financial and economic side of the paper industry picture, we are continuously reminded by financial people of the large expansion programs of the past and the consequent poor financial showing made over certain periods when demand did not keep up with supply. Competition was keen and concerns were establishing their business through the price route, and profits were consequently low. In a rapidly growing country such things are bound to occur. Forward looking people have the courage to go ahead and build for the future as they see it. Two people, with the same idea, doing the same thing, augment the difficulty of oversupply temporarily, and when you have several people expanding their facilities there is always a bad reaction profitwise, for the time being. Again, I refer to the increase in population; when your Association was formed there were only 100 million people in this country—now there are 148 million. In a free country there is no way to build capacity on an accordion-type basis. No one has the power to maintain a perfect balance between production and consumption. Many economic factors change and what was once an economic unit in the production field becomes uneconomic for reasons beyond the control of him who builds it. Perhaps we do not live long enough to observe the effect of such actions and their impact on the whole economy of a particular industry. This situation is not peculiar to the paper industry—it exists in all industry. When we review the chemical pulp industry, for instance, what was once an economic unit with 100 tons daily capacity may now have become one with not less than 300 tons daily capacity.

From a sound, economic standpoint, however, you will always find some bottleneck which is the limiting factor as to long-range economic stability.

In the case of woodpulp manufacture, for instance, if you will take a map of the North American continent and analyze it very carefully, you will realize that there are mighty few timber areas available for economic development. With the cost of construction what it is today and with little chance of these costs being reduced to any appreciable extent in the near future, since labor constitutes such a large part of all construction costs, there seems little likelihood of overexpansion within the industry.

To amplify the reference I have made to timber supply as a governing factor, I would point out that with the increase in size of an economic producing unit in order to get, say 300-tons daily capacity which means a decided increase in its use of pulpwood, and with the tremendous increase in construction costs per ton of daily production, it requires an immense amount of timber area to provide for such a daily production in perpetuity. This must be available timber and timber producing land. By availability I also mean accessibility, and in such a long-range program I do not look for areas on which all of the timber is presently mature.

In talking about mature timber I am always reminded of a conversation which took place some years ago between a pulpmill executive and one of his directors. Each year this executive apologized for a year end charge-off and unsatisfactory financial result by saying: "Well! You see we had to charge off some old pulpwood!" After this had gone on for several years one of his directors said: "Jim, you remind me of my father. Down home we used to put down several barrels of apples for winter use and on Sundays Dad would go down and sort out a few apples for eating Sunday night. He always seemed to find some which showed a few spots and had started to decay and he would come up with a pan full of spotty apples. The next week he would repeat the performance, and the result was we ate rotten apples all winter." That is exactly the thing which will happen in any pulp mill operation if all of the timber supply has reached maturity at the time the pulp mill is built. You must have some young growth coming on which has not reached maturity.

Privately owned timber in this country is pretty well allocated to some particular wood-using industrial development. The policy of the national government, which owns the majority of the usable timber area, has not been such as would allot sufficient area to any one concern to justify the investment of such huge sums as are necessary for the development of an economic producing unit. No one will invest in such development unless he is assured of a timber supply sufficient to maintain continuous operation in perpetuity.

The Dominion of Canada has a far better policy in relation to the establishment of industry within its borders. It recognizes that certain lands were intended for growing timber and it is practical in its ideas that any industry established there must have the backlog of raw material necessary to keep it in operation. The Canadians have profited by their experience and the experience in this country of industries established on a hit-and-run basis, with the resultant ghost towns and economic dislocation.

Every other industry dependent on natural resources has some limitation beyond which it cannot expand. There is a limitation in the amount of water, ore, oil, and every other thing beneath the earth's surface, and the time required for reproduction is beyond comprehension.

We occupy an enviable position in that we can reproduce our raw materials within relatively short cycles of time and perhaps, through genetics or other tech-

(*Continued on page 26A*)

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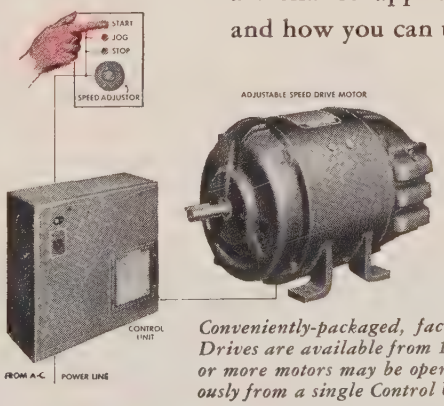

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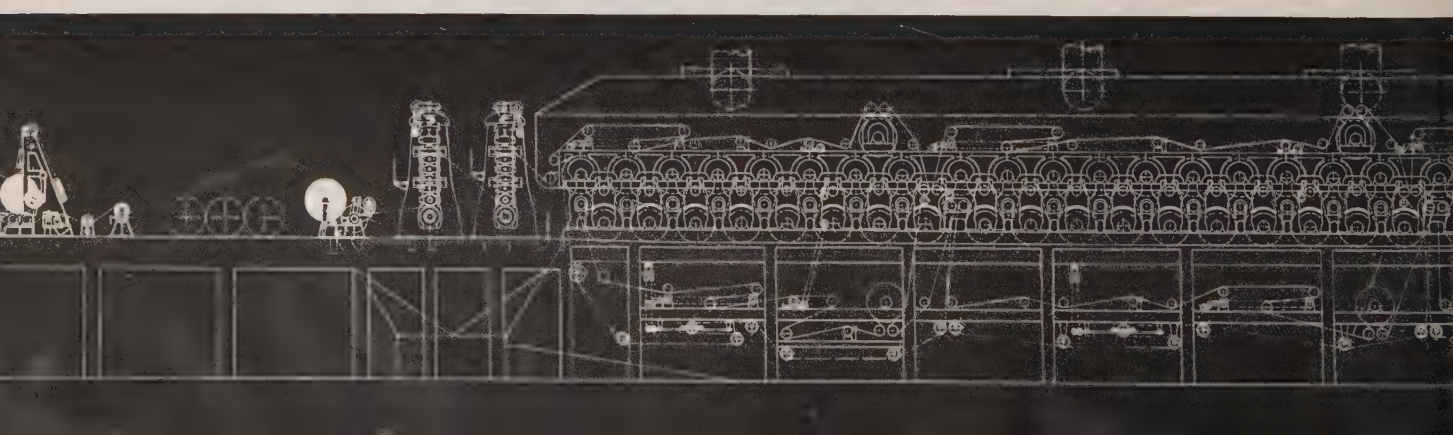
180″ Puseyjones Fourdrinier Machine in Tacoma mill of St. Regis Paper Company is the highest speed, largest production machine ever built for multi-wall Kraft Bag Paper. Designed and constructed for top speed of 2100 F.P.M. Start-up was January 5, 1949.

Line drawing of new machine. Features include latest type Puseyjones Flow Spreader with entirely new closed pressure slice designed to handle 30,000 G.P.M. of stock; Fourdrinier part for wire 180″ wide by 120 feet long with high speed shake, raising and lowering device, and "Rapi-drape" wire changer with all adjustments hydraulically operated, and all framework Monel covered; Press part of latest Simplex arrangement; special creping attachment; Dryer part arranged in four separate driven sections; latest type Steam Joints with dual revolving siphons; Dryer bearings with Lucite windows for observation; two Calender stacks with pneumatic loading; improved high-speed Reel; Slitter and Winder of latest two-drum type with roll-handling device hydraulically operated; all rotating parts including drying cylinders balanced dynamically for top driving speeds.



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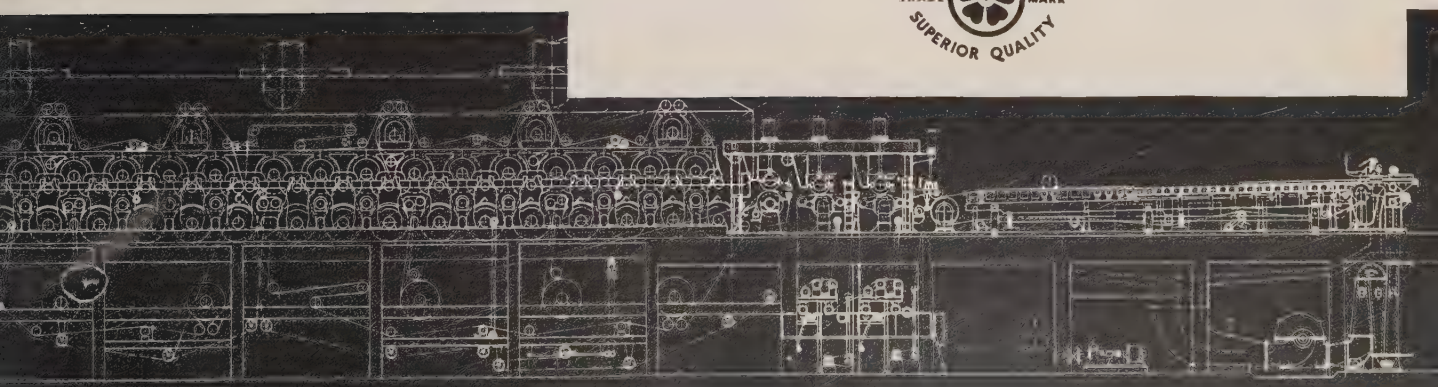

(*continued from page 22A*)

nical knowledge arising through your research activities, reproduce a better and more uniform raw material than we have had heretofore. Henry Wallace is supposed to have done it with corn, and I would hate to think that with your combined intelligence you could not do with trees what Henry did with corn.

When I spoke to you in February, 1941, on "The Impact of the Defense Program on the Pulp and Paper Industry," I had no idea that, within my lifetime, I would ever have occasion to talk to any group again on the subject of preparedness. In that speech I referred to what we did in 1917, and it is a sad commentary on things in general that for the third time in thirty-two years I am commenting on a possible impending military preparedness program which is so distasteful to all of us, and yet, as a matter of self-preservation, we must face with apparent increasing regularity. In 1941 I emphasized an expenditure of "fifteen thousand million dollars" as though it were a colossal sum. Today, we call such an amount "fifteen billion" and it doesn't create a bit of excitement and becomes only a part of the budget.

As I have said many times, I do not know whether there will ever be another war. I do know, however, that, with the changes in defensive and offensive equipment and the necessity for skilled technicians in so many fields of development, the armed forces will require a staggering amount of men, machinery, and equipment, if we are to maintain ourselves as a free and independent nation.

You are all familiar with the problems we encountered from 1940 to 1945, inclusive. The setting is not the same as it was in 1941. Then, we were at home and the initial program was one of defense; now, our armed forces are scattered all over the world and we must have more than a mere defense program. No one knows how, when, or where we may become embroiled in some situation from which we cannot back down nor avoid. It is not a pleasant thing to contemplate but it cannot be cured by wishful thinking. Put yourself in the position of those who are charged with the responsibility of the safety and security of the country and you will realize that one must be practical and face the issue. Having been associated with the program of defense for nearly fifteen months prior to the declaration of war in 1941, I think I can see the pattern of what confronts us. Primarily, this means to me the most severe dislocation of personnel we have ever had. With the present high rate of employment I also visualize a manpower shortage greater than ever before. This will extend to all phases of our industry and, particularly, in the production of pulpwood and the collection of waste papers and other secondary materials.

Most of you know what we were called upon to do before and with the highly technical and specialized developments of the last few years, you can expect more demands on your technical staffs to keep pace with the new program. As I said in 1941, "This year will be a test of the versatility of industrial management and also a test of men and women engaged in scientific research and development."

If this program is inaugurated, I know you will meet the situation as you did before.

One of the objectives of this Association, when it was formed, was the dissemination of information among people within the industry. Through one means or another you have done a magnificent job of carrying on such work. No one ever dreamed that the work of your Association would develop into such a tremendous business. You have had excellent guidance and business administration, which dispels the idea that scientists and technical men have no appreciation of how to run a business.

The crowning effort seems to have now been reached in the advent of your publication, *Tappi*, which has met with such widespread approbation within your membership and within the industry. In this publication you have the opportunity of disseminating information covering all of your combined work in the research and development field, and in preserving for the future technicians of the industry the record of your accomplishments. They can take it where you leave off and this should be of immense benefit to future generations and the maintenance of the industry itself.

In closing the only thing I want to stress is to get action on the most pressing problems. These may have to do with economies in operation, new materials, public opinion, new uses, utilization of byproducts, or a hundred and one other things, but whatever these may be, for Heaven's sake make your decisions as to the mode of attack—*and get action!*

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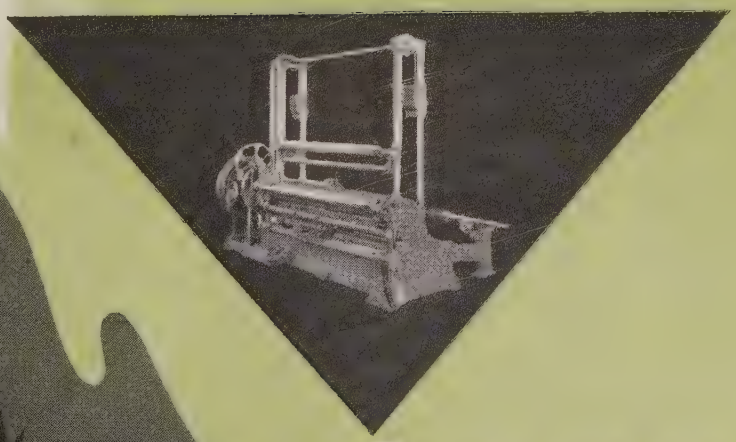

Langston

SLITTERS AND ROLL WINDERS

EDITORIAL Tappi COMMENT

Next on the Agenda

The 1949 annual meeting has passed into history. It is always a noteworthy event or composite of events. So much happens during Paper Week, and so fast, that it is quite necessary to read the convention issues of the various trade magazines after the meeting to find out just what did happen. These convention numbers are usually mammoth in size and may be considered as milestones that mark an industry's progress.

Observing the individuals who attend, one cannot help but feel that everyone has a number of particular reasons for being present, apart from the kaleidoscope of organized programs that proceed relentlessly from Sunday to Friday. Attending the meeting is not a casual thing. Nearly everyone has a personal agenda that includes attendance at certain sessions or even at the reading of certain papers, individual conferences, company business, meetings of other associations, etc., etc.

There is no time for waste motion. Every minute must count, including the evening hours when the principal Broadway hits must be seen. Many services have been devised to meet this situation. The printed program tells what, where, and when, and to this is appended the digests of the papers themselves which amplify the "what." Walden Sons and Mr. Mott help out even further by reviewing the days events in their breakfast-table "Convention Daily." They go further and tell who has registered and where they can sometimes be found. Paper Week is an important one and its cumulative value cannot be appraised by any known yardstick.

Coating at Grand Rapids

The TAPPI Coating Sessions at the annual meeting have always been subject to S.R.O. conditions. The coating industry appears to radiate from New York and Chicago. Until this year its technical meetings have been held in New York. Dr. Werner Kaufmann, Chairman of the TAPPI Coating Committee, has, for some time, followed the practice of conferring the full responsibility of planning and conducting meetings on individual committeemen. This year Bill Kirkpatrick of the Allied Paper Mills in Kalamazoo has the assignment. The committee felt that the midwest area should have one of these meetings. Consequently, the Coating Conference this year will be held at the Pantlind Hotel in Grand Rapids, Mich., on April 26–27, rather than during the annual meeting in New York. This will be a national meeting.

Statistics and Quality Control

The Association has devoted great effort over the years to the development of reliable and meaningful testing methods. During the past few years a new group has been functioning in the Association under the leadership of Dr. Truman A. Pascoe of the Nekoosa-Edwards Paper Co. and Chairman of the TAPPI Statistics Committee. The committee has held sessions at the annual conventions and many have attended with the expectation of learning some statistical facts. For many, the papers presented created bewilderment that made them wish that they had kept afresh their instruction in college mathematics.

From time to time the writer has been asked to explain, in simple terms, the objectives of the Statistics Committee. This request was passed along to Dr. Pascoe, who responds as follows:

"The TAPPI Committee on Statistics has two main objectives:

"First, through various educational means, to effect the introduction and use of certain simple mathematical and graphical methods into the pulp and paper industry that will present *routine test and inspection data* in such form that they give greatly increased guidance in the conduct of manufacturing and other production operations. The best known and most used of these methods have been known for some time but have been recently formulated and simplified by Shewhart and designated the 'Control Chart Technique.'

"The second objective has to do with promoting the use of certain mathematical methods for the more precise and complete analysis of *experimental results.* Through the use of these methods it is possible to draw valid conclusions that can be expressed in numerical instead of descriptive terms. It is also often possible to discover unexpected conclusions that would normally remain hidden in the data. This category also includes the evaluation of test procedures and testing instruments.

"The adoption of these methods in many industries is very general. A national society, made up of workers in this field, is in existence with numerous local sections. The paper and pulp industry is lagging far behind in the adoption and use of these techniques.

"The statistical tools used are simple arithmetical expressions that have been formulated to describe the laws of chance and variation. In many instances the original mathematical expressions have been greatly simplified with parts of the calculating labor reduced through the use of published constants, tables, charts, and the like."

Following Costs

From time to time we note items published in certain house organs that we feel should receive wider attention. Recently, in the Management Brief issued by

(*continued on page 30A*)

This folder can save you MONEY!

...Write for it Today!

Heppenstall Company—makers of the first successful solid alloy steel chipper knife—again sets the pace in knife design. We now introduce *standard slot dimensions* for chipper knives!

Careful research has established the practicability of this development. And its economy is evident. By standardizing chipper knife slot dimensions, costly engineering and manufacturing operations can be eliminated.

These standard slot dimensions can be used throughout the industry . . . chipper knife operations will be unchanged . . . you can use the same disk. Purchasing will be easier . . . *deliveries improved* . . . your chipper knife inventories will be reduced. Naturally, you can still depend upon the same steel analyses, heat treatment, and long service life that have made Heppenstall E.I.S. Chipper Knives the standard of quality.

HEPPENSTALL COMPANY
4620 Hatfield Street, Pittsburgh 1, Pa.

EDITORIAL COMMENT

(*continued from page 28A*)

Rogers and Slade we came across the following good advice:

"In making capital expenditures or authorizing new projects, the initial cost is usually weighed much more carefully than are what one executive refers to as 'following costs.'

"Yet as every businessman knows, often these costs are greater than the original investment or appropriation.

"To prevent drifting blindly into future expenditures, the executive referred to above applies what he calls the What-Goes-With-It? test to all proposals for capital expenditures, and to all new projects or programs put up to him by his associates. This test is in the form of a series of ten questions which bring out the costs that are likely to follow the initial expenditure, either in executive time or in some form of money expense. Hence the term 'following costs.' His questions are:

1. Whose time will it take and how much of it?
2. Will it require additional office or factory space, how much, and what will it cost to provide it?
3. Will it require expensive maintenance, and of what character and frequency?
4. Will it entail additional accounting forms or procedures?
5. Will it be likely to involve legal problems or complications?
6. Will it lead to extra sales or advertising expense?
7. Will it require special literature, and of what character and cost?
8. Will it involve running up substantial bills for travel or entertaining?
9. Is it so technical or specialized that the employment of experts will be required?
10. Will it lead to extravagance in the operation of our business?

"This executive says that it has been his observation over the years that from three to six of these 'following costs' are usually involved in any capital expenditure or new project; and that his associates and subordinates would almost invariably overlook or underestimate some of these costs.

"'If not forced to face my pet test questions,' he observes, 'they would seldom give much thought to them until they had made the capital investment, or launched the new project or program. Then they would be surprised—sometimes quite chagrined—to discover what they had let the business in for.'"

Westward Ho!

In 1934 and 1940 the Technical Association held its fall conventions on the Pacific Coast. Again, in the fall of 1949, the TAPPI Pacific Section will be host to the Association members. If there had been no World War II an earlier date would probably have been chosen. The West Coast meeting is always a somewhat glamorous affair. Special transcontinental trains, visits to the giant woodlands, immense sawmills and pulp mills, and the presentation of fine papers.

In addition to its high standard of technical sessions the event offers a holiday, that for many is in the "one in a lifetime" class. In 1940 many cruised to Alaska. This year, as in 1934, the famous Pendleton Round-up is a feature that many can enjoy. September 11 to 15 are dates that should be circled on many calendars.

integration

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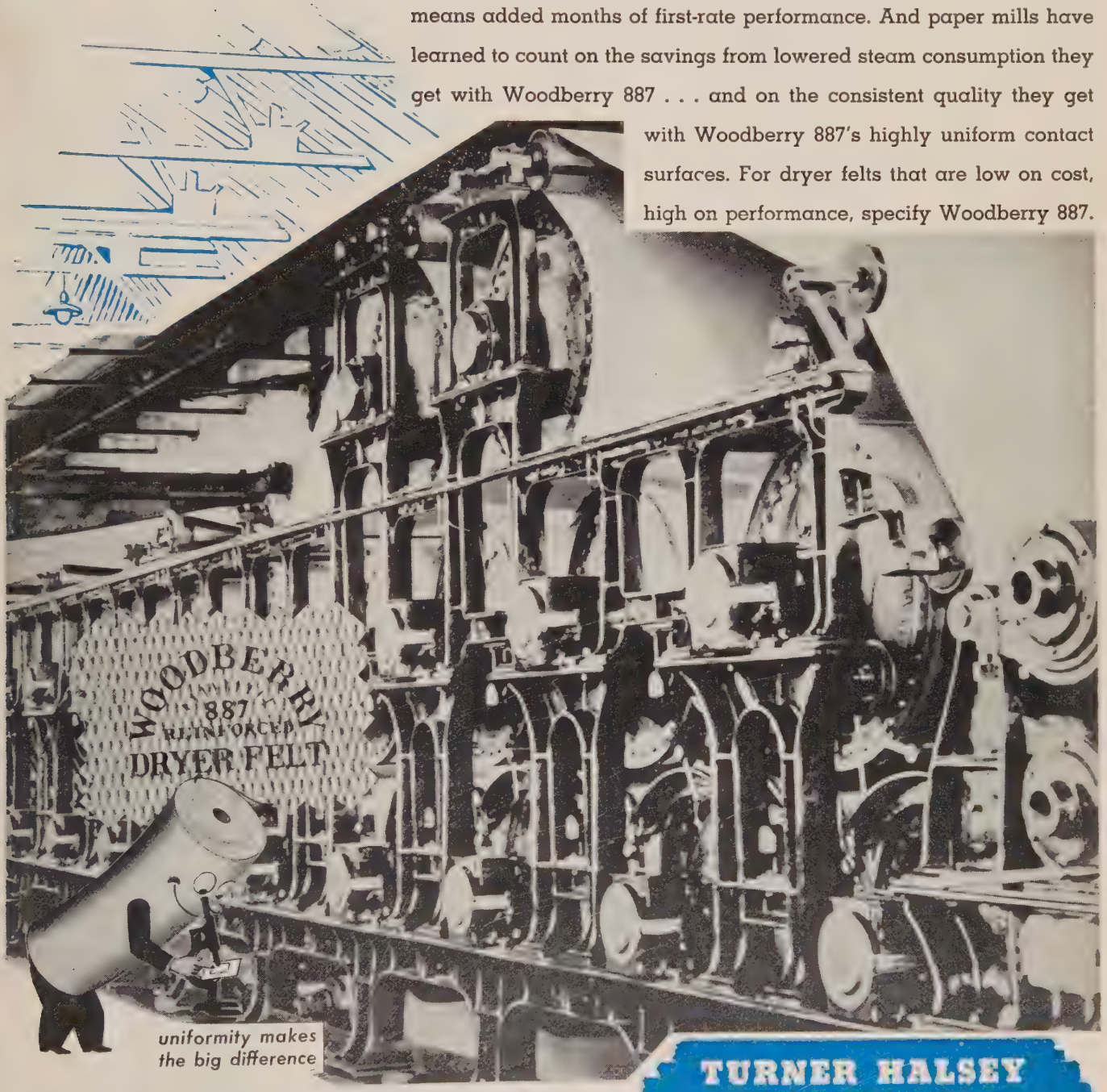
Each step in the specialized production of paper machine wires—including drawing and annealing—is performed by Appleton Wire Works, Inc, . . . another reason why Appleton Wires are Good Wires.

APPLETON WIRE WORKS, INC.
APPLETON, WISCONSIN

Reinforced for Lower Costs Woodberry 887 Dryer Felts

You'll find smoother operation and longer wear in these reinforced heavy-duty dryer felts. Woodberry 887's patented feature—asbestos yarns woven at scientifically determined intervals into their face—means added months of first-rate performance. And paper mills have learned to count on the savings from lowered steam consumption they get with Woodberry 887 . . . and on the consistent quality they get with Woodberry 887's highly uniform contact surfaces. For dryer felts that are low on cost, high on performance, specify Woodberry 887.



Mt. Vernon-Woodberry Mills

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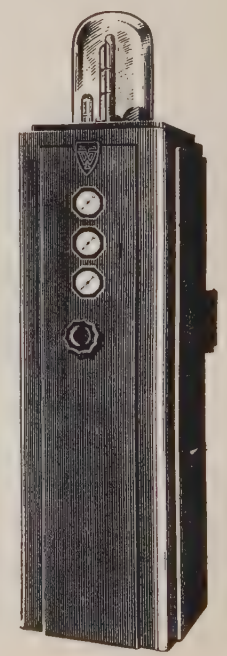
CHLORINATION KEEPS SLIME OFF YOUR PAYROLL

Of course slime doesn't actually stand in the monthly payroll line, but nevertheless it *does* cost you money just as effectively — for example, off-quality breaks, stock losses and screen plugging.

To reduce these losses on your cost sheet, use a method already proven by performance in scores of paper mills throughout the country — Break-Point Chlorination, engineered by Wallace & Tiernan.

Applied to your fresh-water supply after a careful survey by Wallace & Tiernan Engineers, this method controls slime by destroying its major cause—bacteria. Moreover, Break-Point Chlorination used in conjunction with chloramines or other corrective chemicals for stock or white water treatment, can ensure production of a sterile paper or board—a factor of prime importance in food and dairy packaging.



Write today to learn how these advantages of Break-Point Chlorination—backed by Wallace & Tiernan's 35 years' experience in water purification—can go to work for your mill.

WALLACE & TIERNAN COMPANY, INC.

CHLORINE AND CHEMICAL CONTROL EQUIPMENT
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1-18

How to make a doctor live longer

TYPICAL SOAP FLAKER ROLL *on which doctor blades of rugged, rustproof "K" Monel serve dependably, and require infrequent regrinds.*

There may be a tip for pulp and paper mill operators in the remarkable performance of this doctor blade.

It's used in the manufacture of soap flakes, and operates against a heated cast iron dryer roll. Blades previously used had to be honed every hour, and reground every three days.

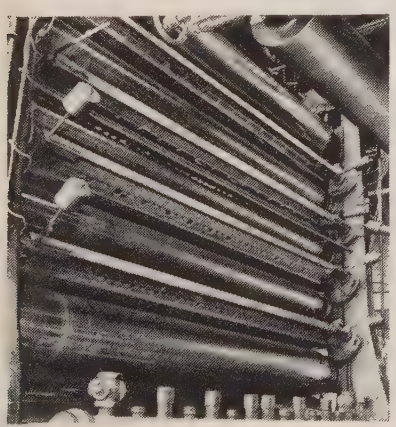
The present "K" Monel blade runs 24 hours without honing, goes 27 days between regrinds, and lasts *nine times as long.*

A rustproof nickel alloy, "K" Monel has all the strength and hardness required for tough jobs in pulp and paper mills, too. It is especially suited for creping heavy paper and specialties, for use against dryer and flaker rolls, or hard rubber covered rolls.

For less severe services against calender rolls, or against brass, bronze and chrome rolls, use regular Monel . Although it does not have "K" Monel's *extra* strength and hardness, Monel is highly satisfactory on wet machines and filters, color and ink scrapers, and in the finishing of wallpapers.

Both Monel and "K" Monel are stronger and tougher than structural steel. Both show stubborn resistance to wear and corrosion. Contact edges of doctor blades remain smooth and even, thus protecting the surface of the roll.

When corrosion and wear strangle the efficiency of your equipment, put Monel or "K" Monel on the job. They'll help you increase output, eliminate a lot of maintenance work... and cut costs.



MADE FROM FULL HARD *Monel strip, these doctors speed output of a 119" Fourdrinier.*

MONEL DOCTORS *on chilled cast iron calender rolls do not score or mark the roll surface. Blades were manufactured by the* Ohio Knife Co., *Cincinnati, Ohio.*

"K" MONEL
MONEL

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK 5, N.Y.

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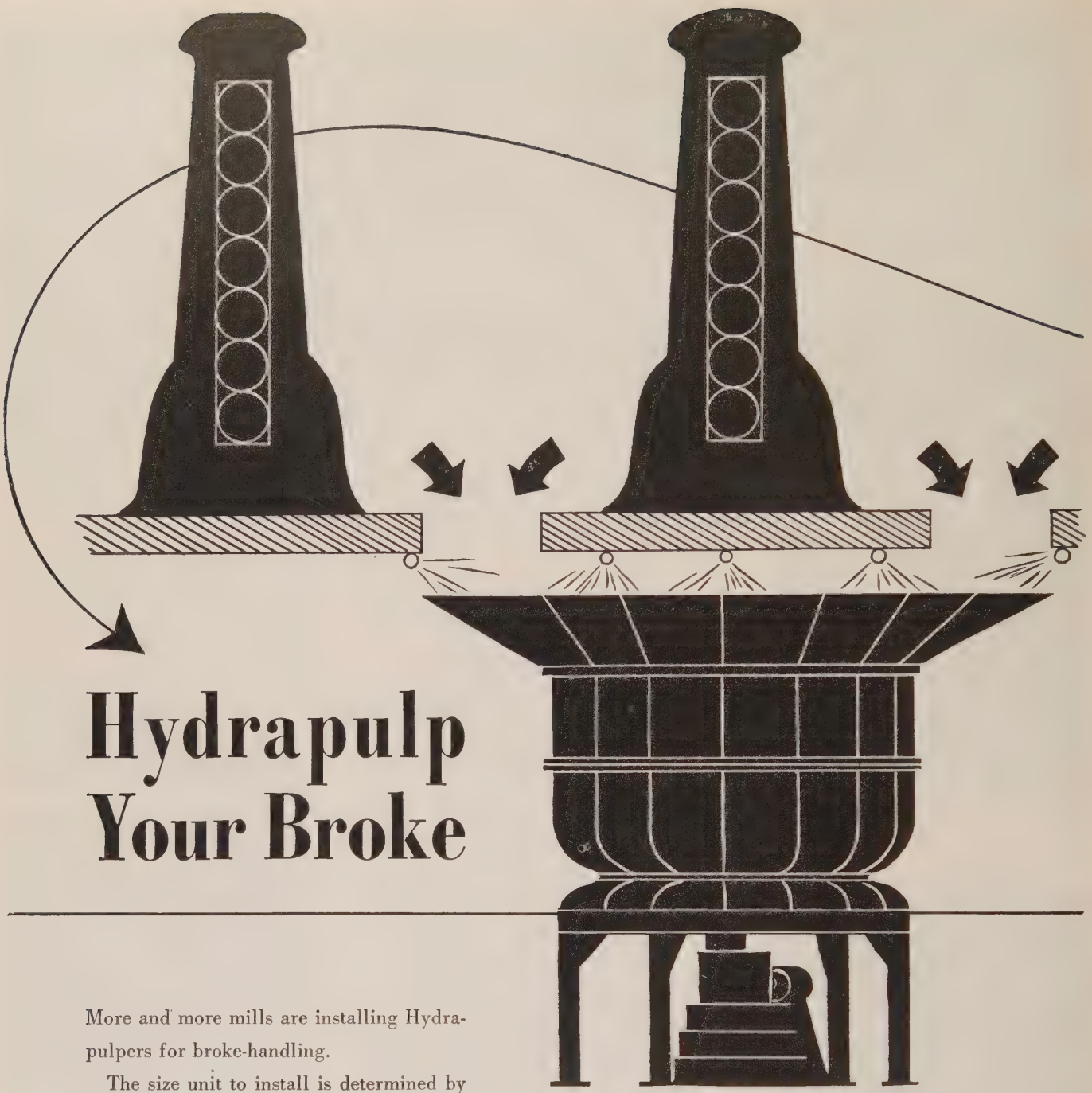

Hydrapulp Your Broke

More and more mills are installing Hydrapulpers for broke-handling.

The size unit to install is determined by dividing the production of the machine by four and choosing a size capable of slushing that amount of stock in an hour—in other words, fifteen minutes' production.

As a rule, the best location is under the calenders and winder where broke from the dry end dryers and entire finishing end can be dropped to the tub as fast as produced.

Broke Hydrapulper speeds vary—slower when slushing the normal machine trim, faster when a break occurs.

This variable speed arrangement and other special features of broke Hydrapulpers gladly explained.

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Peroxide Bleaching of Groundwood

Recent Developments and Commercial Status

J. S. REICHERT and R. H. PETE

The peroxide process for bleaching groundwood is now in commercial operation on an extensive scale. Paper mill operations have shown that bleached groundwood can be used with technical and economic advantages in the manufacture of a wide range of papers. This paper presents a comprehensive summary of the peroxide process for bleaching groundwood. It gives a history of the process and includes a description of such factors as (a) the chemistry of peroxide bleaching, (b) bleaching equipment, (c) operation of the process, (d) variables in the process, (e) applications of the bleached pulp, and (f) a bibliography of pertinent literature and patent references. Peroxide bleaching of groundwood in mixtures with sulphite pulps is likewise in successful commercial operation. A description of the process for bleaching mixtures of groundwood and sulphite pulps is therefore included in this paper.

THE LITERATURE on peroxide bleaching of groundwood is not extensive prior to 1930. The earliest reference found was a German patent (*45*) issued in 1905; a corresponding U. S. patent (*46*) was issued in 1907; the process described in these patents is multistage and includes bleaching with sodium peroxide and chlorine. Robinson (*56*), in a U. S. patent issued in 1927, describes a treatment of mechanical pulps with sodium peroxide for the purpose of achieving a more complete separation of the fibers and the formation of a stronger, tougher, cleaner, and more uniform paper. Curran, Schafer, and Pew (*7*), in a paper presented at the TAPPI meeting in 1934, report the results of studies on groundwood bleaching at the U. S. Forest Products Laboratory; their investigations included both oxidizing agents and reducing agents; they found the oxidizing agents, particularly alkaline peroxide, more effective than the reducing agents for bleaching groundwood. Heritage (*48*), in a U. S. patent issued in 1938, describes a rapid, high-temperature bleach with peroxide made alkaline with sodium silicate; he reports a marked increase in brightness and also a material improvement in color permanence, with less fading on exposure to heat and light. Kauffmann (*51*) in a U. S. patent issued in 1939 describes a process for peroxide bleaching of wood pulps at high consistencies. Craig (*44*), in a U. S. patent issued in 1940, describes a two-stage groundwood bleaching process, first with alkaline peroxide and then with sulphurous acid or an acid sulphite. U. S. patents issued in 1940 (*54*) and 1942 (*55*) to Reichert, McNeight, and Potter refer to the bleaching of mechanical pulps with sodium peroxide under controlled conditions of temperature and alkalinity. A publication by the U. S. Bureau of Standards (*40*) in 1942 reports an improvement in the stability of groundwood to light due to bleaching with sodium peroxide.

At a meeting of the Empire State Section of TAPPI in 1943, Beeman (*2*) presented a paper describing briefly the sodium peroxide bleaching of groundwood, the properties of the bleached pulp, and the applications of the bleached pulp in paper manufacture. In a symposium on "Sodium Peroxide Bleaching of Mechanical Pulps" at the annual meeting of TAPPI in 1944 the status of this development was presented in a series of seven papers on different phases of the subject (*3, 10, 26, 27, 28, 34, 39*). A publication by Lee (*20*) entitled "St. Regis Successfully Bleaches Groundwood" describes the operation of the groundwood bleaching process at the Norfolk mill of the St. Regis Paper Company.

Two papers (*22, 29*) on peroxide bleaching of mechanical pulps were presented at the annual meeting of TAPPI in 1945. The first deals with high-density bleaching and the second covers major aspects of commercial operations. Goodwill (*9*) in 1945 presented a description of the technical aspects of commercial operation of the process. McEwen (*53*), in a Canadian patent issued in 1945 describes a pretreatment of groundwood with a mineral acid prior to peroxide bleaching. Two papers (*24, 31*) presented at the TAPPI meeting in 1946 describe the influence of bacteria and enzymes on peroxide bleaching of groundwood. Coleman (*6*) presented a paper on the peroxide process for bleaching groundwood at a meeting of the Northeastern Division of the American Pulp & Paper Mill Superintendents Association in 1946. Shearer (*58*) in a U. S. patent issued in 1946 describes a process for bleaching groundwood with peroxide on the grinder. A paper by Reichert in 1947 (*33*) gives a progress report on optimum conditions for operating the bleaching process, on the design and layout of bleaching equipment, and on the use of bleached groundwood in paper manufacture. Stobo and Russell (*38*) presented a paper at the 1947 meeting of the Technical Section of C.P.P.A. describing the effects of wood species, pulp consistency, and the pH, time, and temperature on the brightness increases obtained in bleaching. Publications by Lee (*19*) and Simons (*37*) in 1947 describe in detail the peroxide bleaching installation at the Bucksport Mill of the St. Regis Paper Company. McEwen (*52*) in a Canadian patent issued in 1947, describes the effect of a neutral hypochlorite pretreatment on the peroxide bleachability of groundwood pulps. Kingsbury, Lewis, and Simmonds (*15*) presented a paper at the 1948 annual meeting of TAPPI showing the response of groundwood pulps

J. S. REICHERT and R. H. PETE, Electrochemicals Department, E. I. du Pont de Nemours & Co. (Inc.), Niagara Falls, N. Y.

from several hardwoods and softwoods to one-stage bleaching with 2% sodium peroxide and with 10% available chlorine as hypochlorite. Adams and Hughey (*41*) in a U. S. patent issued in 1948 describe the effect of a caustic extraction on the bleachability of groundwood with peroxide.

The du Pont investigational work on applications of peroxides in the pulp and paper industry was started in 1937. The data developed from these early studies lead to the basic conclusion that peroxide bleaching will increase the brightness of wood pulps to a considerable degree, with little or no degradation of the cellulosic or noncellulosic constituents of the wood fiber, i.e., the strength of wood pulps is not impaired by peroxide bleaching and there is little or no weight loss in the bleaching operation. These favorable findings indicated that peroxides might be used with technical and economic advantages for bleaching the various types of wood pulps for paper manufacture.

Bleaching of mechanical pulp was of special interest in the United States at that time. Many of the newsprint mills were facing the necessity of converting their mills to the manufacture of higher grade papers. Groundwood was known to impart desirable characteristics to papers, such as high opacity, good formation, and excellent printing properties. But the brightness of groundwood was too low for extensive use in the production of higher quality papers, and there was no known procedure for raising the brightness of groundwood to the desired level.

A thorough study of the peroxide process for bleaching groundwood was made in the du Pont laboratory, where the best conditions for operating the process were defined. The first extensive mill trial on the production of magazine paper (*Fortune*) with bleached groundwood in the furnish was made in the Norfolk mill of the St. Regis Paper Company in 1941. The bleaching operation was carried out successfully in simple equipment. Paper produced with 60% bleached groundwood in the furnish met requirements as to quality at a substantial reduction in cost. Although wartime restrictions on chemicals and man power curtailed further development work at that time, the production of bleached groundwood was continued at this mill on a limited scale throughout the war years for use in government printing papers and in *V*-mail paper used by the armed forces. As wartime restrictions were gradually released the peroxide process for bleaching groundwood was extended to other mills. The first operations were necessarily carried out in makeshift equipment or in existing equipment not particularly well suited to efficient bleaching operations. The experience gained from the operation of these low consistency batch-type bleacheries eventually led to the design and construction of more efficient peroxide bleacheries. The interest in peroxide bleaching of groundwood grew rapidly during the postwar period and has become industry-wide. For the present the use of peroxide-bleached groundwood in paper manufacture is limited by the amounts of peroxides available for the bleaching process.

Development work on peroxide bleaching of sulphite pulps has been showing a favorable trend for some applications. Lee (*19*) describes the process for bleaching mixtures of groundwood and sulphite pulps in operation at the Bucksport mill of the St. Regis Paper Company.

CHEMISTRY OF PEROXIDE BLEACHING

The hypothesis that peroxides in a bleaching reaction must decompose to form water and nascent or atomic oxygen, the latter being the active bleaching agent, has given way to a newer concept of the reaction. The modern concept of the mechanism of peroxide bleaching, which is now quite generally accepted, postulates the dissociation of the peroxide into ions. The ionization of hydrogen peroxide may be expressed as follows:

$$H_2O_2 \leftrightarrows H^+ + HO_2^-$$

The HO_2^- ion is considered to be the active bleaching agent. The formation of HO_2^- ions is promoted by neutralizing the H^+ ions with an alkali, as would be expected from the Law of Mass Action; conversely, the reaction may be reversed by addition of an acid (H^+ ions).

Under adverse conditions hydrogen peroxide decomposes into water and oxygen gas, according to the following equation:

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

The wasteful decomposition of hydrogen peroxide is promoted by metal catalysts (notably copper, iron, and manganese); the catalytic effect of heavy metals is retarded by stabilizing agents.

Little is known about the nature of the chemical reactions involved in the bleaching of wood pulps with peroxide. Investigation of the mechanism of peroxide bleaching of groundwood is currently being carried out at the Institute of Paper Chemistry (*35*). Preliminary reports on this investigation indicate that there may be a change in the methoxyl content of the lignin component. Shriner (*35*) reports that hydrogen peroxide opens the ring of anthocyanin to form a colorless double ester which, on further treatment with alkali, is hydrolyzed to colorless hydroxyphenylacetic acid. Lewis (*15*) substantiates these observations with the further suggestion that with the relatively small amount of peroxide normally used in groundwood bleaching the anthocyanins are not immediately destroyed.

It has been suggested (*38*) that the action of peroxide on pulp is a selective oxidation and/or hydrolysis of some of the traces of organic coloring matter naturally present in the wood. The fact that cellulose and lignin undergo little or no change during the peroxide bleaching process lends weight to this hypothesis.

CHARACTERISTICS OF PEROXIDE BLEACHED GROUNDWOOD

Many of the basic properties of bleached groundwood depend upon the type of wood used and on the pulping procedure. It is well known that the proper species and quality of wood must be selected and that the wood must be seasoned to the right moisture content, well cleaned, and carefully ground with close control of temperature and stone surface, to give the desired properties as measured in bulk, freeness,

strength, and opacity. Peroxide bleaching does not bring about substantial changes in these properties.

Brightness

Improvement in brightness is the most important result from the bleaching treatment. The brightness increase obtained in bleaching depends upon a number of factors, such as the species and condition of the wood, the brightness of the unbleached pulp, the percentage of peroxide used in bleaching, and the bleaching conditions, notably alkalinity, consistency, temperature, and time of bleaching.

With groundwood at a higher brightness level it is possible to include a substantial percentage of groundwood in a paper furnish and still maintain a satisfactory paper brightness. The effect of an increase in groundwood brightness on the color of groundwood papers is accentuated by the opacity and covering power of groundwood as compared to the longer-fibered sulphite and sulphate pulps. Consequently, an increase in the brightness of the groundwood in a paper furnish results in greater increases in paper brightness than would be expected from averaging the brightness readings on the pulps used in the furnish.

Stability

The stability of groundwood to sunlight or the ultraviolet lamp is not improved to an appreciable degree by the bleaching treatment. Stored away from light the bleached pulp and also papers containing bleached groundwood are quite stable; a drop in brightness from 67.2 to 66.4 was observed in a storage test of over two years. Bleached groundwood shows good stability in heat drying over the paper machine. The loss in brightness usually encountered over the paper machine with unbleached groundwood, is normally not encountered to the same degree with peroxide bleached groundwood.

Opacity

Since the bleaching treatment removes color from the pulp, a corresponding decrease in opacity is to be expected. As shown by Beeman and his co-workers (*3*) this is true, however, only to a small degree. High percentages of bleached groundwood can be used in furnishes to produce papers in which the properties of high opacity and high brightness are combined. Rhodes (*34*) reports that a 62-pound sheet containing 60% bleached groundwood has the same opacity as a 75-pound free sheet.

Bulk

The bulking properties as measured either in the pulp or in the paper are very nearly the same before and after bleaching.

Freeness

Groundwood gives about the same results in freeness tests before and after bleaching. While the freeness of groundwood is not appreciably changed by bleaching, nevertheless, the working properties are better and the drainage rate on the paper machine is higher with the bleached pulp.

Strength

The strength characteristics of groundwood do not appear to be improved or impaired by the bleaching treatment. However, data on paper strengths indicate a trend toward increased strength with the bleached pulp.

Formation

This increase in strength may be due to a more uniform formation on the paper machine since it is apparent that the bleaching process softens and mellows the pulp. The finished paper has a smoother and more velvety feel and does not show the harshness frequently associated with unbleached groundwood sheets. It is more homogeneous and is finer in texture than corresponding grades of paper made with unbleached groundwood (*3*).

Cleanliness

Fiber bundles and dirt specks present in unbleached groundwood are softened and largely disappear in the bleaching treatment. Slime formation is eliminated from the bleaching system and dirt does not develop from this source.

Absorbency

The water absorbency of groundwood and of groundwood papers is improved by peroxide bleaching; this improvement in absorbency is retained on storage. Also, bleached groundwood does not affect absorbency as much as unbleached groundwood in papers treated for wet strength. The absorbency toward oil is high and rapid.

Printing Properties

Groundwood papers have desirable printing characteristics. They have an inherent resilience or compressibility which permits them to be printed uniformly with less pressure. Unbleached groundwood prints well but necessitates a sacrifice in the appearance of the paper; peroxide bleaching improves both appearance and printability.

OPERATION OF THE PROCESS

Bleaching wood pulp with peroxide is a simple process which includes three basic operations, namely:

1. Rapid and thorough mixing of the peroxide bleaching solution with the pulp in controlled proportions.
2. Retaining the peroxide treated pulp long enough to permit the bleaching to go to completion.
3. Reducing and neutralizing the bleached pulp to the desired pH for the paper furnish.

In a typical operation of this process, the peroxide bleaching solution is prepared in a dissolving tank equipped for vigorous agitation. The tank is charged with water. A small amount of magnesium sulphate is first dissolved in the water, followed in order by the required amounts of sodium silicate and sodium peroxide. After the peroxide is dissolved, enough sulphuric acid is added to adjust the solution to the proper alkalinity. The unbleached groundwood is metered to the system at a controlled consistency and

is thickened and/or heated as required. The pulp and the peroxide bleaching solution are then thoroughly mixed in controlled proportions and held in a continuous retention tower or in multiple holding chests where the bleaching reaction goes to completion. The bleached pulp is neutralized and the residual peroxide is reduced by a treatment with sulphur dioxide after which it is ready for the paper machine furnish.

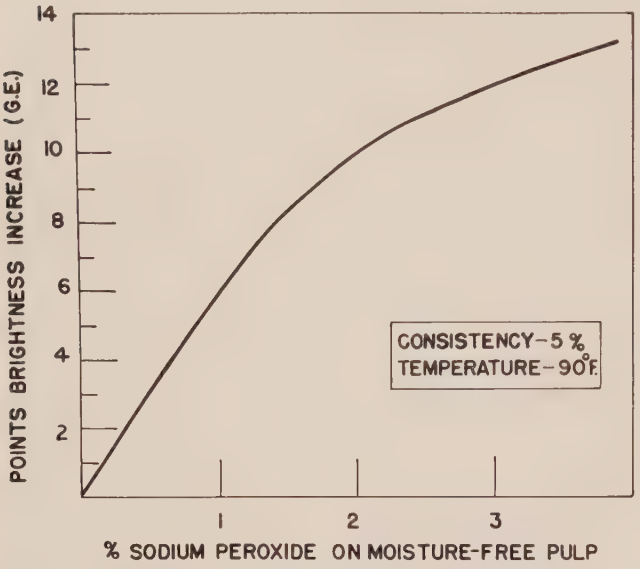

Fig. 1. Brightness increase with increasing amounts of sodium peroxide

The preferred type of bleaching equipment and procedure depend to a large extent upon the quantities of pulp to be bleached, the equipment already available in the mill, and other local variables.

VARIABLES IN THE BLEACHING PROCESS

Process Variables

The chemistry of the peroxide bleaching process is not thoroughly understood; however, an extensive program of laboratory investigations and a wide experience in commercial mill operations have produced a good working knowledge of the variables in the groundwood bleaching process. Many of these variables are interdependent; i.e., a change in one variable necessitates a change in one or more other variables. However, while it is not possible to predict the exact requirements for a specific case, most of the variables may be closely defined.

Percentage of Peroxide Used in Bleaching. Economic considerations and brightness requirements will normally dictate the amount of peroxide to be used. From an efficiency standpoint, the range of 1 to 2% sodium peroxide (or its active oxygen equivalent in hydrogen peroxide) based on the weight of the pulp, appears to be most practical. Figure 1 shows the brightness increases normally obtained with increasing percentages of sodium peroxide.

Pulp Consistency. The consistency of the pulp during the bleaching treatment has a marked effect on the brightness gain and on the bleaching time. As shown in Fig. 2, there appears to be a straight-line relationship between the brightness increase obtained with a constant amount of peroxide and the pulp consistency expressed as pounds of water per pound of stock. The magnitude of the effects of pulp consistency on bleaching time and bleaching efficiency, is approximately as follows: when groundwood is bleached with 2.0% sodium peroxide at 90 to 100°F. a brightness gain of about 10 G.E. units may be expected in 5 to 6 hours at 5% consistency; at 12% consistency

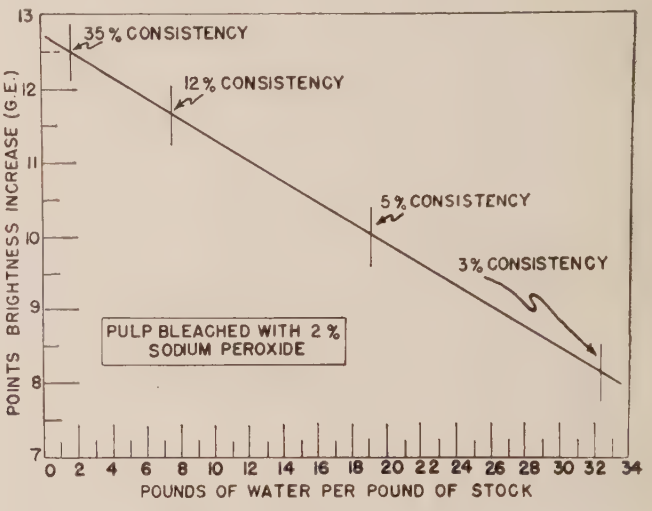

Fig. 2. Effect of consistency on brightness gain

the brightness increase will be about 11.5 points in 2 to 3 hours; at 35% consistency a brightness increase of approximately 12.5 points is obtainable in about 30 minutes.

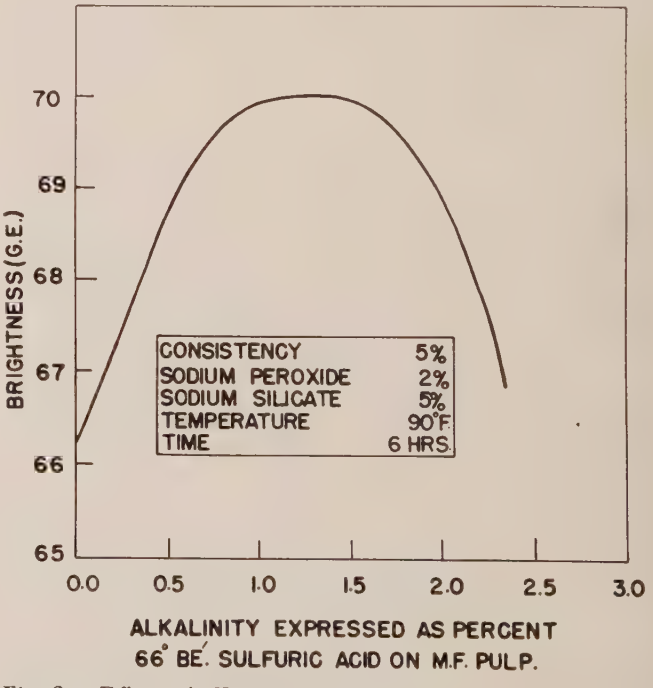

Fig. 3. Effect of alkalinity on brightness of bleached pulp

Alkalinity. The alkalinity and pH of the peroxide bleaching solution may be varied by the addition of sulphuric acid, sodium silicate, or caustic soda. For a maximum brightness increase and a minimum bleach-

ing time, the groundwood after adding the bleaching solution should have a pH value between 10.0 and 10.5.

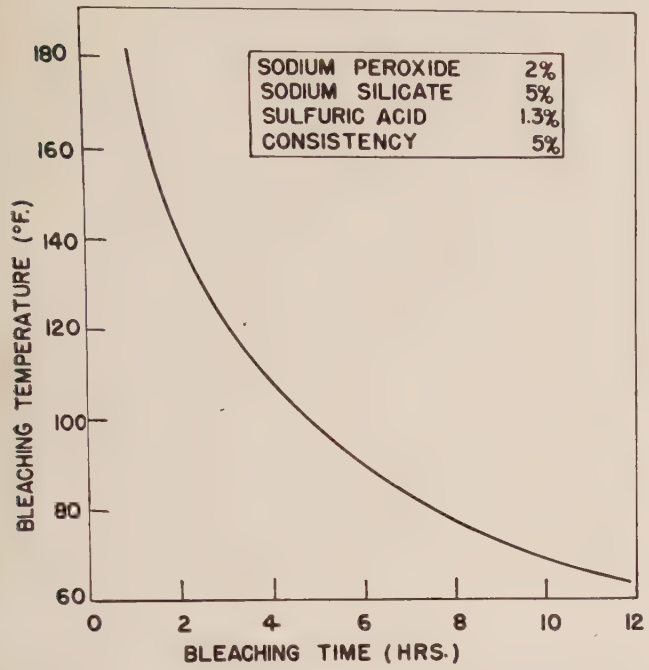

Fig. 4. Effect of temperature on bleaching time required to reach maximum pulp brightness

The total alkali, calculated as NaOH, will at the start fall between the limits of 1.2 to 1.9% based on the moisture-free weight of pulp. The higher alkali value is preferable for bleaching at a low consistency and a low temperature whereas the lower alkali value is desirable for bleaching at higher consistencies and higher temperatures. As shown in Fig. 3, the alkalinity must be controlled within definite limits to obtain the maximum brightness increase.

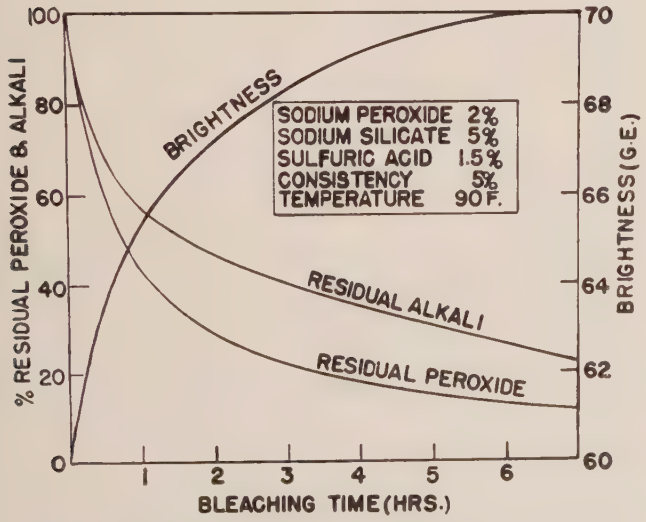

Fig. 5. Increase in brightness and decrease in peroxide and alkali concentrations during bleaching cycle

Bleaching Temperature. At a constant consistency the time required to obtain the maximum brightness increase depends principally on the temperature at which the bleaching is carried out. In general, the bleaching time increases about twofold for every 18°F. (10°C.) drop in temperature. As an illustration, bleaching at 5% consistency and 90°F. requires 5 to 6 hours for completion whereas at 115°F. the bleaching will be substantially complete in about 3 hours. The relation between bleaching temperature and bleaching time is shown in Fig. 4. The preferred temperature of about 100 to 150°F. is within the range generally prevalent in integrated mills. At lower temperatures a longer bleaching time necessitates larger bleaching towers or chests; at higher temperatures the bleaching time requires closer control.

Bleaching Time. The time for completing the bleaching process is dependent on the variables previously described. The progressive increase in brightness during the bleaching period is shown in Fig. 5. This figure also shows the rate of consumption of alkali and peroxide.

Reducing and Neutralizing Treatment. This operation, applied to the pulp after bleaching, is conveniently accomplished at a low consistency, i.e., 3 to 5%. Sulphur dioxide is most widely used for this treatment; filtered sulphite acid or sodium metabisulphite are also suitable for this purpose. Ordinarily when sufficient reducing agent is added to lower the pH of the pulp to 6 to 7, the residual peroxide will be completely destroyed. With good agitation, this reaction is completed almost instantly. In some cases, when bleached pulp with a low pH value is desired, it may be more economical to use a minimum amount of reducing agent and neutralize to the desired pH with sulphuric acid or alum.

Variables in the Raw Materials

Species of Wood. The bleachability of groundwood varies somewhat with the different species of wood. Spruce, balsam fir, Douglas fir, some kinds of poplar, southern yellow pine, basswood, and birch are known to respond favorably to peroxide bleaching. A study of the bleachability of other species of woods is in progress.

Age of Pulp. In general, somewhat greater brightness increases are obtained when groundwood is bleached immediately after grinding. However, good bleaching results have been obtained with groundwood stored for 6 months and longer. Molding and spoilage of pulp during storage has an adverse effect on bleaching results.

Bacteria and Enzymes. Mechanical pulps are particularly susceptible to bacteria, algae, and fungus growths. The conditions in groundwood mill waters and in groundwood slurries are generally favorable for their development. Many strains of bacteria present in groundwood systems are in the enzyme-generating class. Among the enzymes produced in the metabolism of bacteria is the enzyme catalase. This enzyme is characterized by the property of accelerating peroxide decomposition. The effect of catalase generated by bacterial metabolism on the rate of peroxide decomposition in a typical pulp bleaching solution is shown in Fig. 6. A similar effect in the presence of groundwood is shown in Fig. 7.

Groundwood containing excessive amounts of bacteria and catalase will not react favorably to peroxide bleaching (*24, 31*). Groundwood having a bacteria

count of approximately 100,000,000 or less per gram of moisture-free pulp will react normally to peroxide bleaching. Bacteria and enzymes can be controlled by heat, chlorinating agents, oxidizing agents, and other bactericides. With good mill practice in slime control it is not likely that tolerable concentrations of bacteria and enzymes will be exceeded.

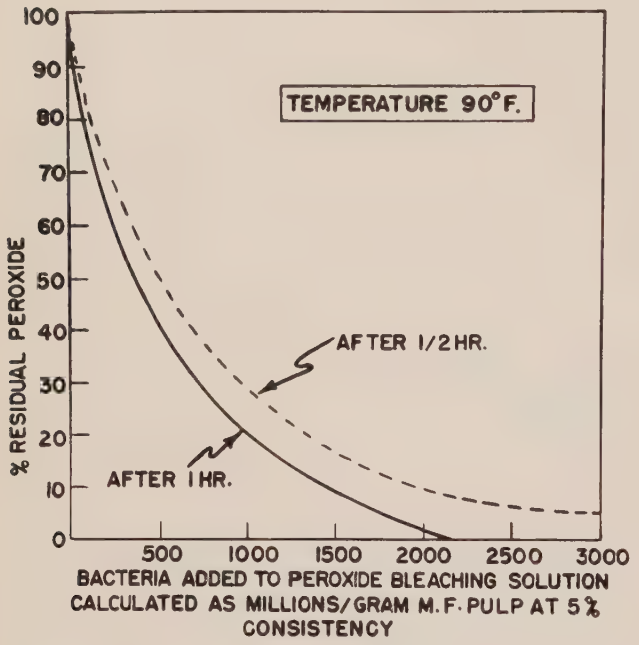
TEMPERATURE 90°F.
AFTER 1/2 HR.
AFTER 1 HR.
% RESIDUAL PEROXIDE
BACTERIA ADDED TO PEROXIDE BLEACHING SOLUTION
CALCULATED AS MILLIONS/GRAM M.F. PULP AT 5% CONSISTENCY

Fig. 6. Relation between bacteria count and peroxide stability in the absence of groundwood

Quality of Water. Water of good quality is an important factor in the production and bleaching of mechanical pulps and also in the conversion of the pulps into paper. Good water is a particularly important factor in the production of bright papers. Colored impurities or color-producing impurities, such as the highly colored iron compounds, cause substantial drops in pulp and paper brightnesses. Under adverse water conditions decreases as great as 14 points in brightness have been observed between the grinder pit and the deckered stock. This subject is covered more fully by Miller (*23*) in a report of the Water Committee of TAPPI.

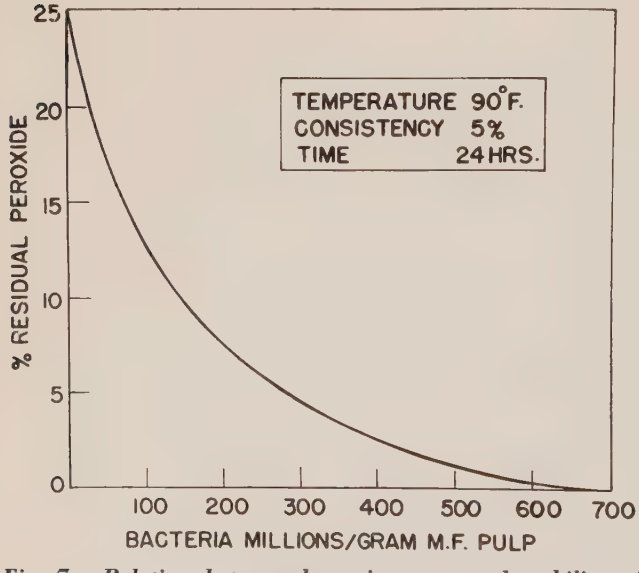

Fig. 7. Relation between bacteria count and stability of peroxide bleaching solution in groundwood slurry

Many of the heavy metals, particularly iron, copper, and manganese have a catalytic effect on the decomposition of peroxide. These metals, normally present in pulpwood and in mill waters, may be in an active form or they may be chemically combined with other constituents of the wood or water in an inactive form. The traces of catalytic metals in pulpwood are comparatively inactive; they are probably tied up as undissociated complexes with organic compounds in the wood; also, their catalytic activity is inhibited by the stabilizing compounds of magnesium and calcium compounds present in the pulpwood. The catalytic metals in the mill waters are likely to be in an active form and are more apt to have an adverse effect on the bleaching results unless steps are taken to deactivate them. Deactivation of these metal catalysts may be accomplished by the addition of magnesium sulphate to the bleaching solution, to the pulp, or to both (*28*).

CHEMICALS

The chemicals used in the bleaching process are sodium peroxide or hydrogen peroxide, sodium silicate, sulphuric acid or caustic soda, magnesium sulphate, and a reducing and neutralizing agent, such as sulphur dioxide, sulphite cooking acid, sodium metabisulphite, sodium bisulphite, or sodium thiosulphate.

Sodium Peroxide is a pale yellow, granular solid containing a minimum of 96% Na_2O_2 and 20% active oxygen. It is shipped in 400-pound (net) drums. It is stable at ordinary temperatures when kept dry in airtight containers. With proper technique it can be dissolved in water with little or no loss of active oxygen. Sodium peroxide is an active alkaline oxidizing agent and may cause combustion of organic material from heat, friction, or limited amounts of water.

Hydrogen Peroxide is available in several concentrations but is marketed principally as an aqueous solution containing 35 or 50% hydrogen peroxide by weight. The 35% solution contains 16.5% active oxygen; at 20°C. it has a density of 1.1327 and weighs 9.439 pounds per gallon. The 50% solution contains 23.5% active oxygen; at 20°C. it has a density of 1.1957 and weighs 9.97 pounds per gallon. Hydrogen peroxide is shipped in 250-pound aluminum drums and in aluminum tank cars. In the concentrated commercial form, it must be kept pure since traces of metallic impurities and elevated temperatures cause accelerated decomposition. It should be stored in the original aluminum containers or in specially prepared storage tanks. If concentrated hydrogen peroxide is allowed to remain in contact with readily oxidizable organic materials, it may cause spontaneous combustion. One pound of sodium peroxide is equivalent in active oxygen and alkali content to 1.21 pounds of 35% hydrogen peroxide (or 0.85 pound of 50% hydrogen peroxide) plus 1.02 pounds of caustic soda.

Sodium Silicate. For use in this process sodium silicate should be water-white and as free as possible from heavy metal impurities; it should have no adverse effect on the stability of peroxide solutions. It

is shipped in 55-gallon steel drums and in steel tank cars. Since sodium peroxide and sodium silicate together supply more than the amount of alkali required for the process, the value of the silicate lies principally in its SiO_2 content rather than in its Na_2O content. When hydrogen peroxide is used as the bleaching agent the required amount of alkali may be supplied by the addition of caustic soda plus sodium silicate or by the addition of sufficient silicate alone.

Sodium silicate has the properties of a detergent and a penetrant. It buffers the bleaching solution and aids in maintaining the pH in the desired range. It forms a protective coating on the surface of metals and inhibits corrosion of metal equipment. It also has a stabilizing action on peroxide solutions under the conditions which prevail in the pulp bleaching process. The amount of silicate used in the bleaching process does not appear to be critical; 5% of sodium silicate (41.5° Bé containing 29% SiO_2 and 8.9% Na_2O), based on the moisture-free weight of the pulp, has proved satisfactory in most pulp bleaching operations. Silicates with other compositions may be used with proper modifications in the preparation of the bleaching solution.

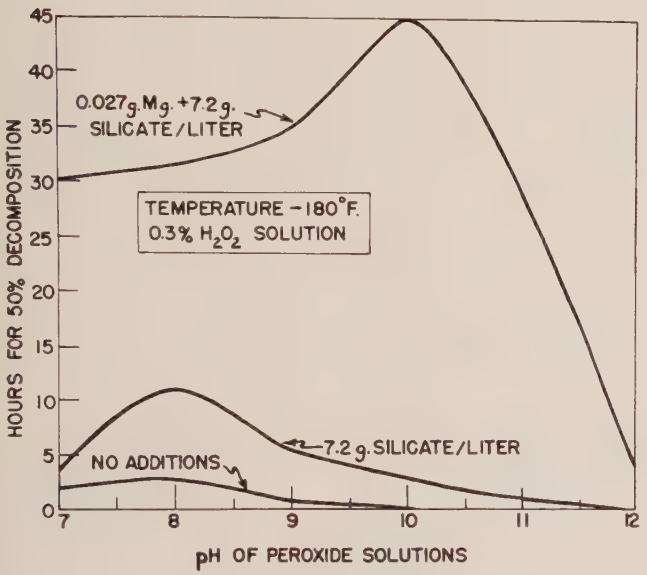

Fig. 8. Effects of magnesium sulphate and sodium silicate on the stability of peroxide solutions

Sulphuric Acid. A clear, colorless grade of 66° Bé sulphuric acid is preferred. This chemical is shipped in 200-pound glass carboys, steel drums, and steel tank cars. For good bleaching results the total alkali content of the bleaching solution must be controlled within proper limits. Sodium peroxide and sodium silicate are alkaline; in general, part of the alkali introduced into the bleaching solution by these chemicals must be neutralized with sulphuric acid. If hydrogen peroxide is used as the bleaching agent the use of sulphuric acid is not required.

Caustic Soda. A clear grade of 50% liquid caustic soda is preferred; it is shipped in tank cars at 50 and 73% concentrations. This chemical is useful in controlling the total alkalinity of the bleaching solution prepared from hydrogen peroxide. The use of caustic soda is the most economical means of supplying this needed alkali although extra amounts of sodium silicate, i.e., over that normally required for stability and buffering, may be used. Mixtures of sodium peroxide and hydrogen peroxide may be used in such proportions that neither caustic soda nor sulphuric acid is required for adjusting total alkalinity.

Magnesium Sulphate. This chemical is available as the hydrated crystalline salt ($MgSO_4.7H_2O$—Epsom Salt). As shown in Fig. 8 magnesium sulphate has a remarkable stabilizing effect on alkaline peroxide solutions under the conditions which prevail in the pulp bleaching process. It performs this function by inhibiting the catalytic effects of the traces of metals, particularly iron, copper, and manganese which are commonly present in pulpwood and in mill waters. The stabilizing effect is obtained with small amounts of magnesium sulphite, e.g., 1 pound of Epsom Salt per 500 gallons of bleaching solution. In some instances where additional stability in the bleaching operation is desirable, a small amount of magnesium sulphate is added directly to the stock before it is mixed with the bleaching solution.

Neutralizing and Reducing Agent. In mills which produce both groundwood and sulphite pulps, sulphite cooking acid is a convenient and economical material for the neutralizing and reducing treatment in the final step in the process. The sulphite cooking acid should be low in heavy metal content and should be free from organic coloring matter, dirt, and sludge; it is desirable to remove any colored solids from the sulphite cooking acid in a small sand filter.

Other reducing agents, such as sulphur dioxide, sodium bisulphite, sodium metabisulphite, sodium thiosulphate, sodium hydrosulphite or zinc hydrosulphite, will also function satisfactorily as the reducing agent. It may be necessary in some instances to use an acidic material, such as sulphuric acid or alum, for lowering the pH to the desired value.

A reducing agent has several desirable effects in the final stage treatment of the bleached pulp. It neutralizes the small amount of alkali remaining in the pulp at the end of the sodium peroxide bleaching step and lowers the pH of the pulp to the desired value. It reduces to the colorless ferrous form the traces of highly colored ferric iron normally present in the bleached pulp. It also destroys the trace of peroxide remaining in the pulp and prevents the development of a pink color which frequently results when unbleached sulphite pulp is mixed with bleached groundwood containing traces of residual peroxide.

CHEMICAL CONTROL TESTS

Peroxide in the Bleaching Solution. The test for the amount of peroxide in the bleaching solution is used to determine the efficiency in preparing the bleaching solution and its storage stability.

Pipet a 10-ml. sample of the bleaching solution into a wide-mouth Erlenmeyer flask. Acidify with 10 to 20 ml. of 20% sulphuric acid. Titrate with 0.297 *N* $KMnO_4$ to a faint pink end point.

1 ml. 0.297 *N* $KMnO_4$ used = 1 pound sodium peroxide per 100 gallons water or 1.21 pounds of 35% hydrogen peroxide per 100 gallons of water

When 400 pounds of sodium peroxide are used in preparing 2500 gallons of bleaching solution, 10 ml. of the solution will require 16.0 ml. of 0.297 N $KMnO_4$ to reach the end point. Under mill conditions this titration will vary somewhat, depending upon the accuracy of measuring the water in making up the solution; however, this titration should be in the range of 15 to 17 ml. When stored under normal operating conditions at 70 to 90°F. the solution should be stable; i.e., after 6 to 8 hours' storage, 10 ml. of the bleaching solution should still require a titration of 15 to 17 ml. of 0.297 N $KMnO_4$.

Alkalinity of the Bleaching Solution. Pipet 1.0 ml. of the bleaching solution into a conical flask, add 100 ml. of distilled water and 3 drops of phenol red indicator; titrate to the first yellow (straw) color with 0.0406 N sulphuric acid.

$$1.35 \times \text{milliliters titration} = \text{pounds alkali calculated as NaOH per 100 gallons}$$

Residual Peroxide in the Pulp Slurry. Prepare a testing solution in a wide-mouth Erlenmeyer flask by adding about 200 ml. of distilled water, 20 ml. of 20% H_2SO_4, 2 to 3 drops of a 5% ammonium molybdate solution, 20 ml. of 10% potassium iodide solution, and several milliliters of arrowroot starch solution.

Take approximately 3.0 grams of peroxide-treated stock (moisture-free basis) and place it in the prepared testing solution. Titrate the sample with 0.1 N sodium thiosulphate to disappearance of the blue color.

Retain the sample after titration and neutralize it with ammonia water. From this sample prepare a consistency pad in a Buchner funnel, press, dry, and weigh the pad.

$$\frac{\text{Milliliters 0.1 } N \text{ Sodium thiosulphate} \times 40}{\text{M.F. weight of pulp sample} \times \%\ Na_2O_2 \text{ added for bleaching (M.F. basis)}} = \%\ \text{residual peroxide}$$

Alkalinity of the Pulp Slurry. Dilute approximately 3 grams of pulp (moisture-free basis) with distilled water and add 3 drops of phenol red indicator. Titrate with 0.0406 N sulphuric acid to the first yellow (straw) color.

Retain the sample after titration and prepare a consistency pad in a Buchner funnel, press, dry, and weigh the pad.

$$\frac{0.162 \times \text{milliliters 0.0406 } N\ H_2SO_4}{\text{M.F. weight of pulp sample}} = \%\ \text{alkali caluculated as NaOH on the pulp}$$

Peroxide in the Pulp After the Reducing Treatment. Remove a representative sample of the pulp slurry after the reducing agent has been uniformly mixed with the bleached groundwood. Place the sample in a small beaker and acidify with 20% H_2SO_4. Add approximately 0.5 ml. of a freshly prepared 10% KI solution and a few drops of a fresh starch solution. If the sample turns blue or black rapidly the slurry contains residual peroxide and additional reducing agent should be added. If after 3 to 5 minutes the sample remains colorless or turns yellow or light brown instead of blue or black, the sample is free of residual peroxide.

Determining the pH of Pulp Slurries. The pH of the peroxide-treated pulp decreases gradually and therefore the pH determinations should be made not later than 5 minutes after the sample is taken. For best results a pH meter based on the glass electrode (with correction for sodium ions) is preferred. The electrode may be placed directly in the slurry and after adjusting for temperature the pH can be read directly.

Colorimetric pH solutions and standards may be used. However, with the colorimetric method of pH determination it is necessary to remove the groundwood by filtering rapidly through cheesecloth before checking the pH in the usual manner. If the solution is fairly clear and the pH reading is near the center of the range for that indicator, the result is reliable. If, however, the pH is near the end of the range for that indicator, the pH reading is open to question.

Preparation of Handsheets. In the preparation of handsheets for brightness determinations the standard TAPPI method should be followed. The data presented by Koon and Niemeyer (*17*) on the weight of pulp used per handsheet, pH of the pulp, quality of water used in preparing handsheets, and moisture content of the handsheets are very helpful in the technique of handsheet preparation. Wide variations in handsheet brightness are encountered when these important variables are not given due consideration.

Fiber Identification. Unbleached and bleached groundwood pulps show distinct differences under the ultraviolet light with the Lofton-Merritt stain. A procedure for the microscopic analysis of mixtures of bleached and unbleached groundwood is described by Graff (*10*).

BLEACHING EQUIPMENT

Structural Materials

In the choice of structural materials for operating the peroxide bleaching process the following factors

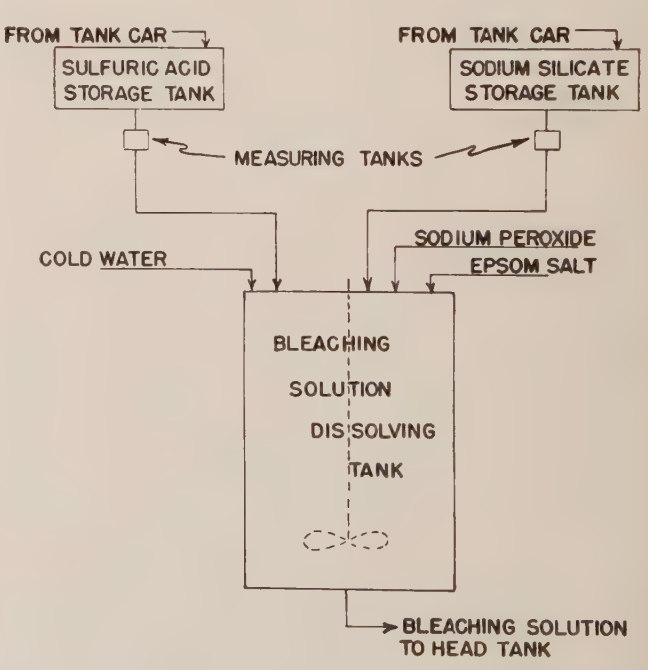

Fig. 9. Preparation of sodium peroxide bleaching solution

require consideration: (1) resistance to corrosion, (2) catalytic effect on peroxide decomposition, and

(3) pulp discoloration. Stainless steel, tile-lined concrete, and rubber-lined steel are generally applicable. Transite and wood are suitable for some applications. Lead and copper are active catalysts for peroxide decomposition and must be avoided in equipment which comes into contact with the peroxide bleaching solution or with the peroxide-treated pulp while bleaching is in progress. Iron is also a catalyst for peroxide decomposition though not as active as copper and lead. In mills where the pulp or the mill waters are abnormally high in acidity, iron equipment is subject to corrosion. Dissolved iron causes a reversion in pulp brightness in any type of pulp and has an adverse effect on bleaching efficiency. Iron is not recommended for equipment which comes into contact with the bleaching solution; it is not a preferred structural material in contact with peroxide-treated pulp while bleaching is in progress though ordinary iron will give a fair performance for this operation if coated with silicate or some other corrosion-resistant material. Entry of lead, copper, and iron into the pulp and mill waters should be avoided or kept to the minimum practical figure. Some kinds of wood (e.g., cyprus and yellow pine) are satisfactory under some conditions; however, at high temperatures and/or high alkalinities, wood fibers tend to soften and swell, resulting in a short life.

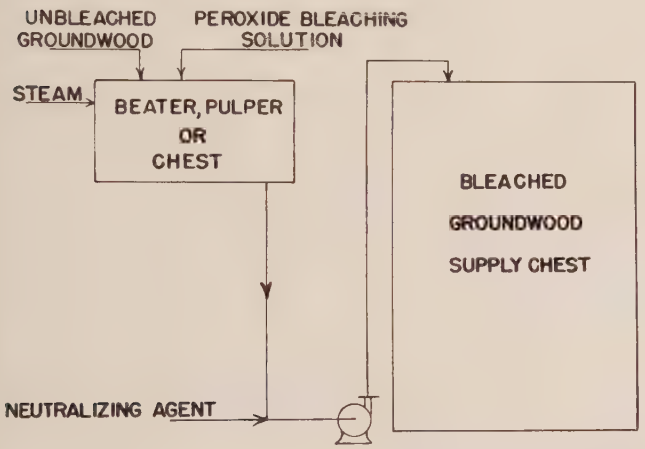

Fig. 10. Low consistency (4–6%) batch bleaching process

Special consideration must be given to the choice of a suitable structural material for each specific application.

Preparing the Bleaching Solution

Preparation of the peroxide bleaching solution is an operation which is common to all types of groundwood bleaching processes. Manual batch operation has been most widely adopted although continuous and automatic operation is being evaluated. Stainless steel is recommended for the dissolving tank. However, acidproof tile, acidproof tile-lined steel or concrete, and rubber-lined steel are all suitable. Wooden and iron tanks have also found limited use. The tank should be provided with vigorous agitation and bottom discharge. The size of the tank is usually in multiples of 2000 to 2500 gallons, since the concentration of sodium peroxide solutions is such that a 400-pound drum requires a minimum of 2000 gallons for efficient dissolving. The required amounts of sodium silicate and sulphuric acid may be delivered from measuring tanks with gravity discharge into the dissolving tank. Aluminum or stainless steel (e.g., 18–8 alloy No. 302) may be used for the hydrogen peroxide measuring tank; steel is suitable for silicate and caustic soda tanks; rubber-lined steel tanks are suggested for sulphuric acid. For continuous operation a storage tank of suitable size should be provided for the bleaching solution; also, control equipment to meter the bleaching solution to the pulp in the desired proportions is necessary. A typical layout for preparing the peroxide bleaching solution with sodium peroxide is given in Fig. 9.

Low Consistency Bleaching

Low consistency (4 to 6%) bleaching may be operated either continuously or batchwise. In batch operation the mixing of the bleaching solution with the pulp, as well as the bleaching and neutralizing, may be done in a pulper, a beater, or a circulating chest as shown in Fig. 10. The production capacity of such expensive equipment may be increased by mixing as described and then transferring the peroxide-treated pulp to a holding tank or chest until the bleaching is complete. By using several holding chests the process may be made into a semicontinuous system such as illustrated in Fig. 11. Stratification of

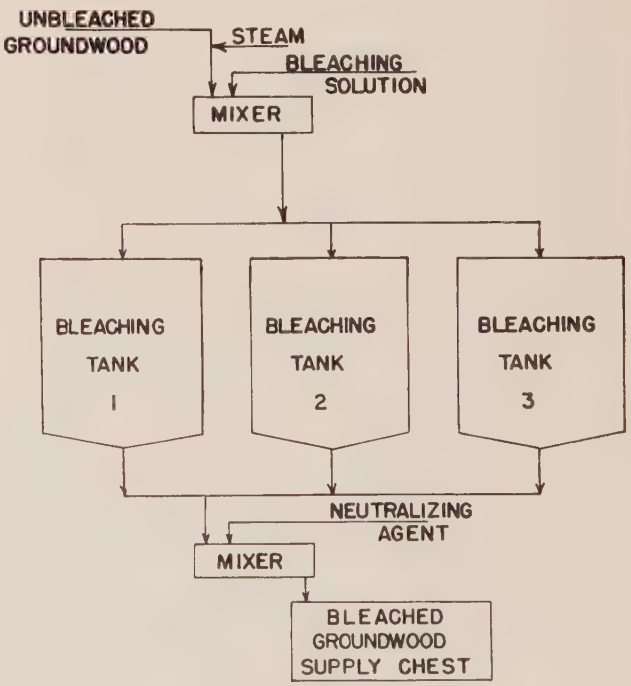

Fig. 11. Low consistency (4–6%) bleaching in multiple retention tanks

the pulp during the holding period should be avoided by agitation.

For continuous bleaching at low consistency a simple mixer is used for introducing the bleaching solution into the pulp. The pulp is then pumped into the bottom of a retention or bleaching tower and overflows into a second mixer where the bleached pulp is re-

duced and neutralized. A typical layout is shown in Fig. 12.

Medium Consistency Bleaching

For bleaching at a medium consistency (9 to 15%) continuous operation is preferable. In this operation the pulp from the deckers is thickened and, after mixing with the bleaching solution, is dropped into the top of a retention tower with a bottom discharge. The bleached pulp from the tower is conveyed into a dilution chest where the neutralizing and reducing agent is added. A typical layout for this operation is shown in Fig. 13.

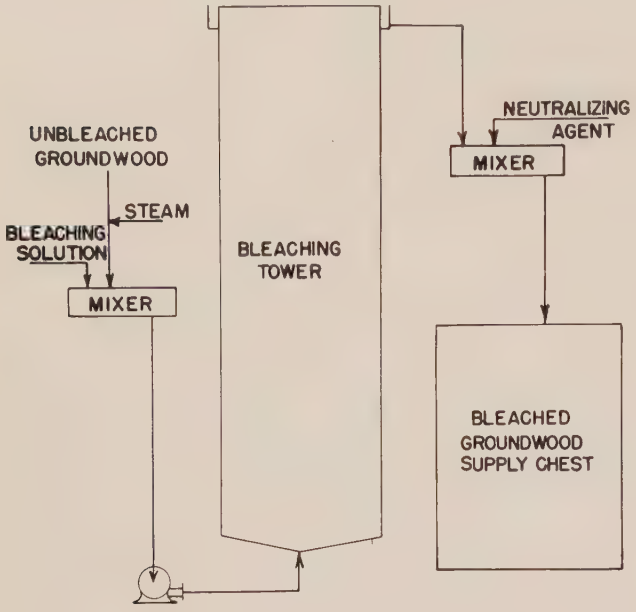

Fig. 12. Low consistency (4–6%) continuous bleaching process

High Consistency Bleaching

Bleaching at a high consistency (25 to 40%) is being evaluated.

Bleaching Mixtures of Groundwood and Sulphite Pulps

For applications in some mills there are advantages in bleaching mixtures of groundwood and sulphite pulps (*19*) with peroxide. This operation is being carried out at medium consistency (9 to 15%) in a layout similar to the one shown in Fig. 13. The unbleached pulps are metered separately, fed together onto the thickener, and the thickened mixture is carried through the remaining steps of the bleaching process in the usual manner.

COMMERICAL APPLICATIONS

Peroxide bleaching of groundwood is in commercial operation in a substantial number of integrated and nonintegrated mills, with an over-all output of about 700 tons per day. Production of bleached groundwood has been limited to this figure by the availability of peroxide to the pulp and paper industry. A large increase in the output of peroxide-bleached groundwood is expected when peroxide becomes readily available for this purpose.

Bleached groundwood is being used to advantage in the production of a range of papers such as book, magazine, catalog, directory, board liner, tissue and towelling, mimeo, tablet, and a number of specialty papers. Bleached groundwood is proving particularly advantageous for the manufacture of raw stock for coated papers; it provides a brighter and cleaner base stock for the production of coated papers in which good appearance and printability are combined.

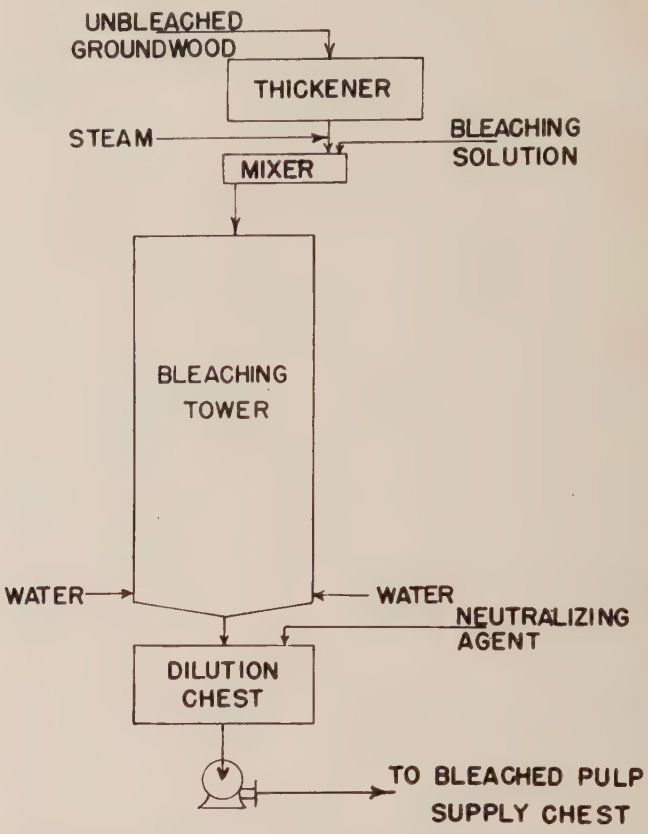

Fig. 13. Medium consistency (9–15%) continuous bleaching process

ECONOMIC CONSIDERATIONS

Conservation of Pulpwood

In the production of groundwood the fiber yields are high (95% or higher) and the weight loss in the peroxide bleaching process is low (1% or less). Use of groundwood in paper manufacture, therefore, provides a means for converting pulpwood into paper with a maximum fiber recovery.

The loss of fiber in the production of chemical pulps varies somewhat with the nature of the processing; an additional loss is incurred in bleaching. In the conversion of pulpwood into chemical fiber the yields are in the range of 45 to 55% for unbleached pulps and somewhat below this figure for bleached pulps.

In the production of fiber from pulpwood for paper manufacture, the yields of groundwood are approximately double the fiber yields obtained in the chemical pulping processes. Bleaching the groundwood with peroxide makes it possible to utilize higher percentages of this high yield pulp in the paper furnish.

Waste Disposal

Disposal of waste products constitutes a major prob-

lem in the production of sulphite pulps; the liquor from the digesters contains about half of the weight of the pulpwood. Waste disposal is a negligible problem in groundwood production.

Savings in Paper Manufacture

Substantial savings in fiber cost are realized by using bleached groundwood for producing papers in which brightness, bulk, opacity, absorbency, and printing properties are important and in which high strength and a long useful life are not essential. The principal savings are based on: (1) lower cost of fiber, and (2) improved opacity obtained in the same weight sheet or same opacity obtained in a lighter weight sheet. Savings of 10 to 20% in fiber costs are obtainable in the production of many kinds of papers; in some types of furnishes the savings are as high as 40% of the total fiber cost.

ACKNOWLEDGMENT

The authors wish to express their sincere thanks to the many chemists, engineers, equipment specialists, plant operators, production supervisors, mill managers, and executives in the pulp and paper industry who have taken an active part, first, in carrying the peroxide process for bleaching mechanical pulps to its present stage of development and, second, in developing the technique for utilizing the bleached pulp in the manufacture of a wide range of papers. In this acknowledgment it is desired to express appreciation also to the men in the printing trade and in the publishing industry who have given valuable assistance in developing the improved printing characteristics in these new types of papers.

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Submicroscopic Structure of Wood Constituents

HERMAN F. MARK

In considering the physical structure of wood constituents in the submicroscopic domain, it seems appropriate to point out at the beginning that there is almost nothing known about the physical structure of such chemical components as rosin, the hemicelluloses, tanning agents, etc. They seem to be distributed over the wood substance in a manner which does not warrant a discussion of structural principles. Lignin appears to be essentially accumulated in the middle lamellae and has been recently investigated by Wyckoff with the electron microscope. He found that a shadow-cast picture of the middle lamellae shows an amorphous, structureless pattern with a number of small, irregular holes and with no indication as to any close chemical relationship between this layer and the cell wall which consists of highly oriented and well-structured cellulose fibrils. Benjamin M. Siegel, who has recently studied a number of plant tissues with the electron microscope, will give a short review of his own results and of the work of Wyckoff and Hock. In the following we shall essentially review the submicroscopic structure of that wood constituent which has been most thoroughly studied during the last 25 years—namely, cellulose.

The discussion of the submicroscopic physical structure of cellulose may be introduced by pointing out that the chemical units of this structure are the macromolecules of cellulose. They consist of long, linear chains which, in some native samples, are formed of as many as 6000 to 8000 glucose residues. It is not known how homogenous these native samples are, but it has been found that all commercial materials, such as bleached and purified cotton linters or wood pulps as produced for paper, cellophane, or rayon manufacture, are rather heterogenous and contain molecules of widely different degrees of polymerization; their average D.P. is between 1500 and 3500. The glucose residues in the chains are held together by 1,4-glucosidic bonds; one end group has the character of an alcohol, the other that of a potential aldehyde group. Recent investigations indicate that this simple picture has to be modified in several directions:

1. All technical samples and, possibly, most native specimens contain carboxyl groups in the 6 position and sometimes also aldehyde or carboxyl in the 2 and 3 positions. The frequency of these groups is small (one in 100 or more glucose residues) but their effect on the chemical and technical behavior of the materials and their concentrated solutions can be considerable.

2. Certain native celluloses appear to contain other bonds along or between the individual chains which, according to Kinell, Pacsu, and Schulz, are more easily hydrolyzed than the normal 1,4-glucosidic bond. Pacsu has suggested that these weak bonds are hemiacetalic in nature and occur in cellulose as well as in starch. There is still certain dissention among recent investigators about the frequency and nature of these "odd" linkages.

The individual macromolecules of cellulose can be very differently arranged in respect to each other and it is this difference in arrangement which represents the submicroscopic physical structure of a cellulose sample. The following cases seem to be particularly characteristic:

(a) The individual macromolecules are arranged completely *at random.* According to Hermans and Kratky, there is always a tendency for a certain order of the chain segments in very small domains (say 20 to 30 A) but, within an individual chain, it changes its direction in a random fashion and there is no regularity in the arrangement of the neighboring chains. Such domains are usually referred to as "amorphous" or "disordered" areas; they have low specific gravity, high water absorption, and high chemical reactivity with many reagents; they are responsible for softness and flexibility of the sample and they produce a diffuse halo in the x ray diagram.

(b) The individual macromolecules are arranged in such a manner that their axes are parallel and that there exists also a complete lateral order in the sense that corresponding groups in the individual chains point in the same direction. As a consequence, one has a perfect three-dimensional order which resembles closely the arrangement of atoms, ions, or molecules in a crystal lattice. Therefore, the areas in which such a high degree of order prevails are usually designated as the "crystallized" or "completely ordered" domains. They have a high specific gravity, low water absorption, poor reactivity, impart to the material a high Young's modulus, stiffness, and tenacity, and produce an x ray diagram having a number of sharp and intense spots.

(c) If the individual chains are parallel with their long axes but are not completely ordered as far as their lateral arrangement is concerned, an intermediable state of axial order but lateral disorder exists. Areas in which this type of organization prevails are referred to by Baker and Fuller as "mesomorphous domains." Their specific gravity, water absorption, and reactivity are intermediate between those of the amorphous and crystalline areas. If, in a given sample, the mesomorphous areas have a tendency to crystallize, the sample will show a tendency to stiffen; if the mesomorphous domains are on the verge of becoming amorphous, the material will show a tendency to soften.

In defining the physical structure of a cellulose sample, it is of great importance to know how much

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of it is in the different states of organization as enumerated above. The presently available methods do not provide for an exact answer to this question but permit only an approximate estimate of the degree of order in a given material. Usually, the results of the various methods are presented as the percentage of crystalline or difficultly accessible areas in a given sample, which probably always comprises the fully ordered domains and in addition a certain, unknown proportion of the mesomorphous areas. The following methods have been proposed up to date.

1. *The evaluation of x ray diagrams.* Earlier attempts by Hengstenberg, Hermans, Kratky, and Clark have shown that this method is applicable in principle, and recent precision measurements of Hermans and Trillat have given improved values for the relative amount of crystalline domains in native and regenerated samples. These studies have also shown that water is being taken into the crystal lattice of native and mercerized cellulose to the extent of two molecules of water for each elementary cell (four glucose residues).

2. *The specific gravity of the material.* Recent precision measurements of Hermans allowed an estimation of the crystallinity in samples of various origin.

3. *The rate of exchange of cellulose with deuterium oxide.* This phenomenon was first observed by Champetier and Valliard and was recently employed by Erilette, Hanle, and Mark to the determination of the proportion of easily accessible domains in a number of cellulose samples.

These three "nondestructive" methods lead to concordant results if applied to the same samples and reveal that most native celluloses consist of about 50 to 60% crystalline material and of about 40 to 50% easily accessible areas. Only a few special samples, such as bacterial cellulose, miniature cotton fiber, and vigorously shredded ramie, contain much smaller percentages of crystalline substance (between 10 and 20%). These highly disordered specimens have a strong tendency to crystallize either upon stretching or upon heating in water or, though slowly, upon standing in the airdry state at room temperature. After "annealing," they exhibit degrees of crystallinity of about 50 to 60%. Hermans has carried out such a crystallization experiment in a calorimeter, has measured the degree of crystallinity before and after the annealing, and has computed the heat of crystallization of native cellulose. He arrived at a value of 5500 calories per mole of glucose.

4. Another interesting method for the determination of the accessibility of cellulose was worked out by Nickerson and later modified and improved by Conrad and Scraggre, Phillipps, Seaman and others. In this method, the cellulose chains are hydrolyzed and the resulting glucose residues are oxidized; its application leads to higher values for the crystalline domains than the three nondestructive methods. According to Brenner, Frillette, and Mark, the loose chain ends which are produced by the hydrolysis undergo additional crystallization very easily, with the consequence that the degree of crystallinity of a sample increases while it is subjected to the Nickerson test.

The properties of a cellulose fiber or film are greatly dependent on the degree of crystallinity, on the orientation of the highly ordered domains, and on the average size and perfection of them. Present information from x ray diagrams and electron microscope pictures indicates that the crystalline domains represent long ribbonlike structures, which are linked together by chain molecules to form long, thin, and approximately cylindrical fibrils, which have recently been studied with the electron microscope by Frey-Wyssling, Wyckoff, Hoff, and Siegel.

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The Structure of Cellulose in the Electron Microscope Range

BENJAMIN M. SIEGEL

The electron microscope can be used to study the organization of structures by direct observation in the range of 50 to 1000 A. As Professor Mark and Dr. Sisson have pointed out, this instrument can thus bridge the gap between the indirect investigations of the submicroscopic structure of cellulose at the intra- and intermolecular level, which is of the order of 1 to 10 A, and the microscopic structure observed with the optical microscope which reveals the structural organization on the micron level. With the special applicability of the electron microscope to this region it is to be expected that this instrument will provide valuable information for determining the organization of the molecules of cellulose in the formation of fibers and provide highly critical data for evaluating current theories obtained from indirect observations. As shall be seen, the molecules are organized into fine fibrils which build up the wall structures and the fibers observed with the optical microscope, and these fibrils are in that intermediate size range for which the electron microscope is such a powerful tool.

In the past, a number of investigators (*1*) have reported studies of cellulose with the electron microscope and there has been general agreement that natural cellulose fibers are made up of fine filaments of cellulose or fibrils. But, up to recently, the work reported cannot be considered definitive since the various

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investigators have reported a rather wide range of diameters for the fibrils observed. The main problem has been one of obtaining sufficiently high contrast with a material of low density such as cellulose. Some of the differences can undoubtedly be attributed to the various preparative techniques which have been used in preparing specimens for the electron microscope, but it was primarily due to the lack of an adequate technique for accurate observation of fibrils of these dimensions which prevented the attainment of more satisfactory results.

The recent development of the shadow-casting technique by Wyckoff and Williams (*2*) has introduced a method of enhancing the contrast of specimens and provides a method for extending the study of cellulose to the fibrillar level. In shadow-casting, a thin layer of a heavy metal is evaporated onto the specimen at an oblique angle, and it is the metal layer which produces an image of high contrast which is a topographical representation of the specimen. Therefore, the density to electrons of the material to be examined no longer determines the contrast which can be obtained and the smallest fibrils of cellulose come under the view of the electron microscope. The shadow-casting technique thus makes possible the study of fibrillar fine structure of cellulose in the same way that it has made possible many other subjects of investigation with the electron microscope.

In this paper the author will review briefly some of the most recent work which has been done on cellulose with the electron microscope which appears to be of real importance. No attempt will be made to give a complete review of current work but the author has been fortunate in obtaining examples of results as yet unpublished or only very recently published which should be of considerable interest. Mühlethaler has been working with Wyckoff at the National Institute of Health in Bethesda, Md., and they have made a beautiful study of the manner in which the fibrils build up in the primary and secondary walls of various plants. They have observed a definite similarity in the structural organization of the cellulose fibrils in the primary walls of all types of plants which they have examined. The fibrils observed have diameters of the order of 200 A and in the primary wall they are randomly interwoven into a network in which there is no preferred orientation of the fibrils. All specimens investigated at the National Institute of Health were prepared by beating a water suspension in the Waring Blendor and shadow-cast with palladium.

The secondary wall of cellulose is formed after several of the randomly oriented network layers have been laid down to form the cellulose structure of the primary wall. The layers of the secondary wall are formed by highly oriented fibrils of the same range of diameters as found in the primary layers of a given type of plant. However, each layer in the secondary layer is highly oriented in bundles of parallel fibrils. In specimens in which the lignin has not been removed, it can be seen interspersed among the fibrils of cellulose. In many cases, the primary layer with its random network can be seen underneath the secondary layer and the randomness of the lower layer is in strong contrast to the highly oriented fibrils aligned in a parallel bundle in the upper layer.

Ritter (*3*) has described some very interesting experiments in which a marked difference was obtained in the x ray diffraction pattern from very young cells and those from the older plant. The very young plant showed a diffraction pattern with rings which can be ascribed to diffraction from cellulose but there was no orientation of the crystallites. However, as the plant grew older, the diffraction pattern indicates a marked orientation of the scattering crystallites. The electron microscope examination gives a definite confirmation of these results found by x ray diffraction. In the primary walls forming first in the young plant, the cellulose fibrils are randomly oriented and, as the plant grows, the heavier secondary walls form with their layers of highly oriented fibrils giving an x ray diffraction pattern dominated by the scattering from these well-oriented structures.

The structure of the lignin with the cellulose removed is of great interest. The lignin present in the primary wall structure of jute as it exists after the removal of the cellulose appears to be an amorphous layer which is dispersed intimately in the network of the cellulose layer of the primary wall with many holes which must be made by the cellulose fibrils which weave in and out.

A very interesting study on native cellulose which, in a way, complements the work just described has recently been reported by Kinsinger and Hock of the Hercules Experiment Station (*4*). They have studied differences in the size of the fibrils which are found in various types of plants, and they have found that there is a marked variation in the average diameter of the fibrils from different types of plants. Ramie, cotton linter fibers, staple cotton, and wood pulp were beaten in the Waring Blendor 15 to 20 minutes and specimens were prepared from the supernatant slurry. The shadow-casting was done with chromium at an angle of 45° and, from the clearly defined fibrillate structures observed, the average diameters of the fibrils were found to be: ramie 370 A, cotton linter fibers 160 A, staple cotton 100 A, wood pulp 90 A. This variation in the size of the average diameter can be seen in Figs. 1, 2, and 3 for ramie, staple cotton, and

Fig. 1. Ramie (Kinsinger and Hock)

wood pulp, respectively. It is to be noted from these pictures that the degree of orientation and smoothness of the fibrils vary in these plants and that the variation of these properties is in the same order as the variation in average diameter. These differences of

Fig. 2. Staple cotton (Kinsinger and Hock)

the fibrils may be expected to have a relation to the differences in the physical and chemical properties of the fibers which they form and, indeed, ramie forms a highly crystalline well-oriented fiber with marked tensile strength but with low elongation and poor reactivity and wood pulp fibers have properties which are in many ways the opposite of those of ramie, whereas cotton is intermediate.

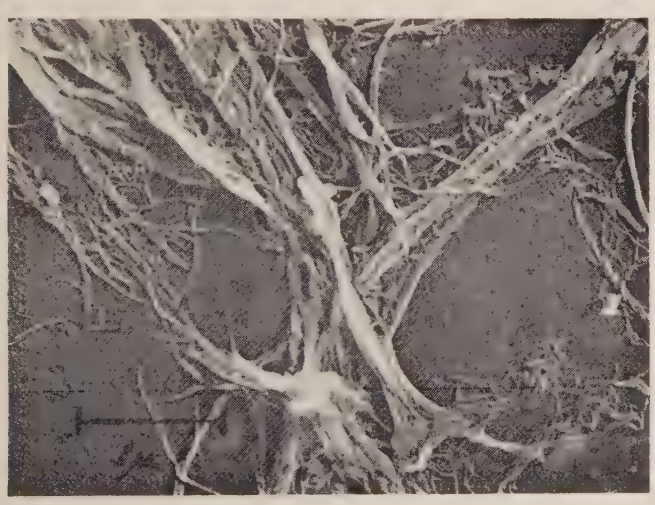

Fig. 3. Chemical wood pulp (Kinsinger and Hock)

In relating the chemical reactivity of the various fibers to the fibril diameters, Kinsinger and Hock point out that the current picture obtained from chemical studies indicates that, when the fibrils are in a highly ordered arrangement, the reaction proceeds along the fibrillar surfaces before the fibrils themselves are attacked. Since the volume of the interfibrillar cellulose is inversely proportioned to the diameter of the fibrils, the reactivity should correlate with the observed diameters of the fibrils. It is interesting to note that the accessibility of ramie, cotton, and wood pulp does correlate in this way.

Kinsinger and Hock have also reported observations on the ultimate structure of cellulose fibrils which is revealed through the use of "electron stains." Since the image in the electron microscope is a magnified shadow of the object (certain regions of the specimen scatter the incident electrons more than other regions), the specimen which has sections containing elements of high atomic number will cause a high degree of scattering in these sections and the corresponding areas will appear quite dense in the final image. Thus, a specimen may be "stained" by preferential association of a heavy metal with the structure which is to be studied. Lead acetate was found to be the best "electron stain" for cellulose and Fig. 4 is an electron micrograph of purified cotton

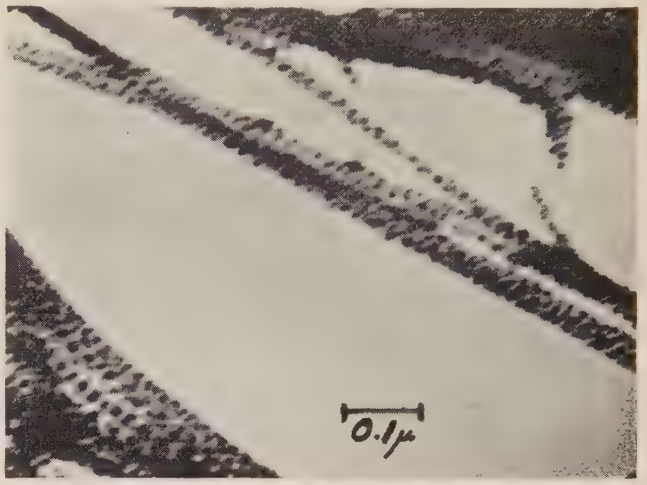

Fig. 4. Cotton linters stained with lead acetate (mag. 90,000×) (Kinsinger and Hock)

linters which have been stained with a 20% aqueous solution of lead acetate for 18 hours at room temperature. At this high magnification definite banding is observed transverse to the fibril axis at intervals of 100 to 200 A. This same banding with a periodicity of about 150 A is seen in shadow-cast specimens at high magnification. Figure 5 is a high magnification of a section of the shadow-cast specimen of staple cotton fibrils shown in Fig. 2, and now the suggestion of a

Fig. 5. Staple cotton (mag. 100,000×) (Kinsinger and Hock)

spiral configuration is clearly evident. The possibility of artifacts in electron microscope observations makes it necessary to be cautious in the interpretation of these pictures and one should be conservative in relating this observed periodicity in the fibrils with the natural untreated state.

Cellulose fibrils are known to break down under more vigorous mechanical treatment into still finer filaments and this phenomenon also has been studied by Wyckoff and Mühlethaler who have investigated the behavior of untreated flax fibrils when they are subjected to sonic vibration of high intensity. Dr. Sisson will show a detailed and thorough study of this technique on various types of cellulose fibers and, therefore, the author only describes a typical specimen of flax which has been subjected to sonic disintegration. It is interesting to observe that the fibrils which, before the treatment had diameters in the 100 and 200 A range, are now separated in many instances into very thin filaments with diameters that range down to 30 or 50 A which is at the limiting resolution of the electron microscope for this type of specimen technique.

The author wishes to thank Drs. Kinsinger and Hock for their kind permission to use the micrographs which are shown here, and Drs. Wyckoff and Mühlethaler for their permission to describe their as yet unpublished work. The interesting and valuable investigations which have been made in their laboratories on the structure of cellulose are examples of how effective and fruitful the electron microscope can be for the study of that intermediate size range in the order of 100 A where all natural substances apparently have important organizational structure.

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DISCUSSION

Dr. Sisson: Professor Mark has developed for you the concept of crystalline and amorphous areas in cellulose fibers and emphasized their importance. In concluding his talk, he mentioned that there was another dimension between that of the cellulose crystallite and the structure visible in the microscope. Our picture here is not complete, but it is developing largely through work with the electron microscope, and so Dr. Siegel, who works with Dr. Mark in his laboratory at Brooklyn, has filled out the picture.

Thank you very much, Dr. Siegel, for covering the subject. In our laboratory we have frequently noticed that, when you disintegrate cellulose fibers, you frequently obtain what looks like wads or tufts of cotton. One gets the impression that, in those areas, you actually have a type of molecular felting. Have you noticed anything like that?

Dr. Siegel: I think it is common. Of course the sample shown here has been prepared by treatment in the Waring Blendor to disintegrate the cells and that could have such an effect.

Allan Schenck: In the electron microscope photographs, are there any indications of lines of weakness that Dr. Ritter mentioned this morning?

Dr. Sisson: I have some slides here which may help to answer your question. They were borrowed from Mr. Morehead of our laboratory who plans to show them at the next meeting of the Electron Microscope Society. (Referring to slide showing schematic arrangement of oriented crystalline areas separated by amorphous areas.) According to the current theory of submicroscopic structure described by Dr. Mark, we would expect native fibers to cleave along these amorphous areas to give fine fibrils. This is confirmed by subjecting fibers to ultrasonic vibration and examining the product in the electron microscope. For example, when cotton, wood pulp, and viscose rayon are subjected to the ultrasonorator, long, slender fibrils of varying diameter are obtained. Rayon gives shorter fibrils than cotton or wood, their nature depending somewhat upon stretching and other variables of manufacture.

If cotton or wood pulp is first subjected to hydrolysis, followed by ultrasonic treatment, the native fibers then break down into very short fibrils or spindles similar to the fusiform bodies described by Dr. Ritter.

However, if rayon is subjected to the same treatment, we obtain not spindle-shaped but oval-shaped particles. If you will refer to the slide showing the schematic arrangement of fine structure, you will notice that, if one assumes the hydrolysis treatment to attack the amorphous areas only, then we would expect the results which we obtain experimentally.

Mr. Morehead has measured the particles obtained by hydrolysis and ultrasonic disintegration with the following results:

Fiber	*D.P.*	*Length Min., A.*	*Length Max., A.*	*Length Av., A.*	*Chain length from D.P., A.*	*Thickness, A.*	*Width, A.*	*No. of chains*
Cotton	280	910	2080	1460	1440	50	64	113
Wood	297	1200	3300	1450	1510	37	45	63
Ramie	251	1120	1400	1200	1280	35	40	53
Fortesan	110	....	....	450	550	27	50	52
Rayon	50–60	....	....	240	250–300	23	50	45

These samples have all been hydrolyzed down to their limiting D.P.—that is, to the point where further hydrolysis reduces the chain length very little. You will notice that the chain length calculated from the D.P. value checks fairly closely with the average length of the particles. This would indicate that the cellulose chain runs the entire length of the particle, and that the hydrolysis treatment breaks the chains only in the amorphous areas. It is possible that these particles from the hydrolyzed fibers correspond to the original crystalline areas in the fiber.

Dr. Heinig: Can cellulose be processed (beaten) with sonic disintegrators?

Dr. Sisson: That would be possible but certainly not economical.

Dr. Mark: I'd like to mention that in talking about density of cellulose and about the conclusions which Dr. Hermans draws from the density meansurements, we should ask Dr. Stamm if he would be kind enough to comment on this subject, because, as you know, Dr. Stamm is an authority on the density of cellulose. He has measured it in all possible mediums, including helium. I think you are doubtful about some of Dr. Hermans' conclusions.

Dr. Stamm: In reading Dr. Hermans' conclusions I am confused about the matter of density. He has made measurements under water, in helium gas and organic liquids and he, too, finds differences, like everyone else, but comes to the conclusion that he is measuring the true density in the nonpolar organic liquid like benzene. To me that is rather nonunderstandable. If we have crystalline and noncrystalline zones and if we make the assumption—we shouldn't say assumption because we have x ray proof that neither water, helium, nor an organic liquid changes the crystalline dimensions and, therefore, it does not come into the oriented zone. To me it is somewhat logical to say that the organic liquid does not completely penetrate the oriented zone and, on that assumption, I think it is all right to make the calculations he does because he is using a lower specific gravity for the amorphous than for the oriented and that is what you get if you are not measuring true specific gravity with the organic liquid. We have made a few measurements with helium that give densities quite close to the values calculated from x ray data. They are just slightly higher, and I would expect them to be because, in the crystalline zone, it is conceivable that there are some unpenetrable interstices; however, in the amorphous zone the helium should bathe the cellulose chains completely and give a specific gravity for the amorphous zone slightly higher than for the crystalline zone. The important thing is that I do not object to Hermans using an organic medium for determining his specific gravity values which he uses for his calculations, but I do object to his calling them the true specific gravity of cellulose.

Dr. Sisson: Dr. Howsman in our laboratory has made density measurements on rayons, which were known to have very small voids. When the measurements were made in organic liquids, it was possible to detect the presence of voids. They affect the over-all fiber density, and this fits in with Dr. Stamm's ideas.

Dr. Shick: Would Dr. Siegel make a statement to the effect that the microscope might be an instrument that would not show the fibrils?

Dr. Siegel: When a fibrillar specimen is examined both with the electron and light microscopes, smaller and smaller fibrils are observed with the electron microscope, but in the light microscope a limiting resolution is reached and beyond that point the fibrils all appear to have the same diameters regardless of their true dimensions. In other words, fibrils which have a diameter less than the smallest resolvable distance will cause a diffraction pattern which gives an image that makes the fibrils appear to have the dimensions of the limiting resolution of the optical microscope.

Dr. Shick: In other words, they get so small they would not disturb the path of light sufficiently to show up the object at all.

Dr. Siegel: That is true. When they get down to certain dimensions, you cannot see them at all.

Dr. Sisson: I assume you all remember the classical paper by Dr. Barnes in which he showed the same field in the electron and light microscope. Here you could see only so far in the light microscope. Below a certain range, all the fibrils visible in the light microscope appeared to be about the same size.

W. Gallay: I wonder if there might be a direct relationship between the breakup of the fibers and the well-known differences in properties of pulps. There is information to show sulphite pulps balloon more readily. There is also some information to show that the sulphite fibers are more brittle than sulphate fibers. Even if there is no obvious appearance of a general crack-up of the fibrils, possibly one can look for a more insipient fiber cracking in sulphite pulps.

Elwin E. Harris: We have to take into consideration constituents other than cellulose when talking of beating properties and reactivity, and they have not been considered. About 40% of the carbohydrate in wood is so-called hemicelluloses, and normally is not considered a part of the crystalline cellulose; still, it is an important part of the reactivating of this material, and, accordingly, is an important part of papermaking.

Dr. Sisson: The photographs which I showed were, of course, of purified pulps. Dr. Siegel's were unpurified and I was very much interested in his photographs showing the lignin structure after the cellulose had been removed. I think it is very interesting in view of the old question as to how lignin and cellulose are associated in the cell wall. I wonder if Dr. Siegel would like to comment further on that.

Dr. Siegel: I am afraid that, at this time, there is not much more than the evidence that is exhibited in the micrograph. The lignin appears to be an amorphous deposit dispersed between the fibril network. The information is too limited as yet to attempt to coordinate it in a complete picture with the evidence from other studies on lignin. Perhaps others who saw the slide have further ideas based on their experience in studies of the characteristics of the behavior of lignin.

Dr. Mark: I think Dr. Wyckoff, who made this beautiful picture in his laboratory, told us about it at the Gordon conference in New London. He was asked the same question and all I can do is to repeat his answer which was that there exists in the photographs no indication for a chemical bond between cellulose and lignin. He would have expected sometimes to find cellulose fibers connected with small patches of lignin but did not.

Dr. Sisson: I can remember years ago we made x ray diagrams of wood. The cellulose diffraction lines were always very broad and, as you removed the lignin, they became sharper and sharper. We interpreted this, at that time, to mean that the lignin was perhaps crystallized with that wood, a mixed crystallinity of lignin and cellulose. This would be not a

chemical bond or a sharp boundary between the two phases, but a situation where one phase gradually blended into the other. It is possible that part of this sharpening of the diffraction lines which we observed may be due to a recrystallization of the cellulose which we now believe takes place when you subject cellulose to purification treatment or degradation. With this in mind, I think we will have to look again at our x ray data.

Dr. Stamm: In seeing that lignin picture, I was a little startled that it represented such a large proportion of the total cross section. In wood you will have about 25% lignin. A large part of it is concentrated in the middle lamella, so that the part in the fiber should be considerably less than this. The technique of making these slides, I understand, involves subjecting them to rather high temperature and vacuum. Is there a chance that the lignin acted as a plastic and spread, giving the impression that it covers more of the cross section than it did originally?

Dr. Sisson: Dr. Siegel, would you like to explain the shadowing technique used in preparing your electron micrographs?

Dr. Siegel: I believe that it is the middle lamella layer that is shown in this picture. Regarding the effects of the shadowing technique, it should be remembered that shadowing gives an image which is the topography of the layer and it is possible to get an impression that the amount of material is much greater than that actually present.

Dr. Stamm: If the picture represents the middle lamella, it looks more like I would expect.

Dr. Ritter: In viewing anything under the microscope, either the light microscope or the electron microscope, the clarity with which we see the specimen will depend on two factors. One will be the difference in the index of refraction of the particle we want to see as compared with that of the material that covers it or surrounds it. Another factor involved is the absorption of light. For example, we have the wood residue from which a major share of the cellulose has been removed and the lignin is left; that specimen will absorb more light than the cellulose part will. You will get dark bands, and so forth. The thing that is bothering me is this: in the ordinary microscope, those two factors are involved. When you use the electron microscope, is the absorption of light more important than with the ordinary microscope or do you also have to depend on the difference between the index of refraction of the specimen you wish to see and that of the foreign material surrounding the specimen area?

Now, I have another question. I believe you said that, after some of the cellulose is removed, the lignin becomes more distinct. If you take out some of the hemicelluloses, you see the markings more plainly than before. Maybe I misunderstood but, if that is the case, does the cellulose residue become more prominent insofar as seeing it is concerned on account of removing something that has a different index of refraction or is it that it absorbs more light or not so much?

Dr. Siegel: Dr. Ritter's questions point up one of the limitations of the electron microscope. Whereas in the light microscope the image is produced by differences in the refraction, absorption, and scattering of different parts of the specimen, in the electron microscope there is only a difference in the amount of scattering of the electron beam by different areas of the specimen that gives you the contrast in the image observed. Actually, in the electron microscope the image is a shadow of the object. You also cannot take advantage of things analogous to colored dyes to get selective staining, for the electron beam is monochromatic. The real limitation arises from the fact that most organic materials have about the same scattering density to electrons, and it is hard to distinguish one material from another. One obtains a differentiation resulting only from different shapes and quantities of the materials. In the shadow-casting technique, which was used in all but one of the micrographs shown, you deposit a metal layer obliquely over the top of the specimen so that there is effectively a shadow where there is no metal behind each raised point of the specimen. What you observe is a topographical representation of the specimen given by the metal layer which, of course, is a good electron scatterer and produces an image of high contrast. In regard to your second question, when you have two interspersed materials each of which scatters about the same amount, you cannot distinguish one from the other except by its structure. The first slide which was shown is the only one in which the lignin had been removed, and one definitely gets increased definition of the fibers in it.

Dr. Ritter: Another question. Since wood is grown in an aqueous medium, it is in a relaxed condition when water soaked. The specimen you photographed with the electron microscope is dehydrated material and everything is under tension. If we examine a dehydrated fiber or fibril microscopically, the specimen appears entirely different than when it is water soaked. I am wondering if, when a wood specimen is dehydrated and crinkled, you would not see some things that you would not see in the water-saturated condition. You cannot do differently with the electron microscope. I am wondering how dehydration will affect the so-called artifacts.

Dr. Siegel: Dr. Ritter is raising another of the limitations of the electron microscope. There is a real problem in relating our observations in the electron microscope to the actual living material or the actual material with which we start. As to what artifacts may have been introduced by the dehydration of wood in the vacuum, the best that can be done at present is to compare the structures after dehydration at low magnifications with the optical microscope and to use other correlative information available from which can be postulated the change, if any, which might be expected to occur.

Dr. Ritter: You may be getting the idea that I do not believe in the electron microscope, but I truly wish we had one, because I know that one can obtain information with the electron microscope that he cannot obtain otherwise. If one gets any kind of checking of the specimen in dehydration, it must indicate some potentially new kind of cleavage.

Another question. When we photograph a specimen under the light microscope and then photograph it under the electron microscope or the reverse, we are not giving the light microscope a square deal because,

in the latter case, the specimen is a dehydrated material; when we do that we have a lot of refraction of light. I always work with specimens in a water-soaked, relaxed condition and I do not think it is fair when we say: "This is what you get with the light microscope, and that is what you get with the electron microscope under comparable conditions." The two photomicrographs were not taken under the optimum conditions for the two instruments. We should be careful when we compare them.

Dr. Tarkow: Would it be possible to get around the difficulty raised by Dr. Ritter by examining cellulose in the form of an aerogel as prepared by Kistler's technique?

Dr. Kerr: Dr. Ritter, I do not think you are presenting the case in all fairness. In the first place, whether you are speaking of wood or textile fibers, you are using dry material and not wet material. We are using dry fibers all the time and we have to know their structure in the dry as well as in the wet condition. Secondly, it is a very common practice (and we have done it all the time) to take dry fibers and put them in a nonpolar solvent; placing them in the proper refractive media gives an indication of the difference between that and the electron microscope. There is a definite shrinkage over the water condition but not a question of something relaxed versus artifacts.

Dr. Ritter: I have no objection at all to your statement that we use wood in a dry state. Sure we do. However, when you do that, you are subjecting it to an observation under the electron microscope where it does not bother you as much, but you are not giving the light microscope a square deal. It is not the optimum condition for the light microscope. When you begin to dehydrate wood you raise Cain with it. You put it under stresses and strains of all kinds and types. I am using the term "relaxed condition" to designate water soaked.

Dr. Shick: Perhaps it would be possible to make a replica of wet wood or wet fiber which could be shadow cast and you would have a replica of the swollen cells in their relaxed condition, which could be observed in the microscope.

Dr. Siegel: The replica technique does provide a possible method for examining a structure such as a wood fiber surface before it is dehydrated in a vacuum. An example is this replica of the surface of a cotton linter fiber. This specimen has been treated but this slide illustrates a technique which can be very useful. It is quite right to say that the replica technique could be used as a check to see if we are introducing any changes at the level we are interested in by dehydration. In one of the common techniques of making a replica of a fiber, an image of its surface is made by impressing it in something like a collodion film which is not quite dry. The surface of the collodion is then shadowed and an electron microscope image is obtained which is a negative representation of the contours of the original fiber surface. Actually, there are other methods that are used to try to get around this whole problem of introducing artifacts by dehydration. One that Dr. Wyckoff has suggested is to use a quick freezing of the material so that, when the sample is evacuated, the water sublimes from the frozen state and, coming out this way, leaves the structure intact. As soon as all the water has sublimed, the specimen is shadowed; no further changes would be expected on subsequent examination in the electron microscope.

Dr. Stamm: I would like to ask Dr. Mark how he reconciles the fact that some of these units which we see in the electron microscope pictures are as short as 200 A and the x ray technique indicates that they are at least 600 A long.

Dr. Mark: The figure of 600 A or more was derived from measurement of the width of the diffraction lines of native ramie which had not been given any pretreatment. However, in such degraded materials as we have just seen on Dr. Sisson's slides, one would have to measure the width of the lines and then make the calculation. Qualitatively, these lines seem to be much broader than those of ramie; hence, I suspect one would obtain a smaller value than 600 A for these materials. Dr. Hermans, with his improved technique, is now engaged in a more thorough study of the average lengths of the crystalline areas of various materials with x rays. In this connection I think it is also appropriate to mention Dr. Roseveare's method; he removes the amorphous portions by hydrolysis and then measures the degree of polymerization of the remaining material. In this way he obtains the so-called *limiting D.P.* For native celluloses the limiting D.P.'s are of the order of 300.

I am very anxious that you should not be left with a wrong impression. I agree very much with what Dr. Harris has said. The fact that we did not speak much about organic chemistry today does not mean that organic chemistry does not play an extremely important role in all questions of cellulose chemistry, but the job today was to discuss the physical structure of cellulose in the range from Angstroms to microns. Of course the reactivity of cellulose depends to a large extent upon its organic chemical nature. So, please do not think that I do not fully appreciate the importance of organic chemistry for cellulose, but today's subject was to discuss the physical-chemical side of it.

Dr. Ritter: The hemicelluloses with which we have worked thus far have always been dissolved and then precipitated, which procedure removes all structure. It seems to me that, if we could remove the alpha-cellulose, lignin, extractives, and none of the hemicelluloses, we could get at the structure of the hemicelluloses. I think that would be worth going after; and I believe it can be done. In attempting the operation we run up against one difficult barrier. We have to dissolve out some extremely resistant material and retain a rather soluble substance. You saw that it could be done with extractives. You stabilize those soluble materials so that you can dissolve out everything else. That is what I want to do with the hemicellulose. Why isn't it possible to do that? Here is the clue to it: first, the hemicelluloses are distributed throughout the cell wall. They extend from the cell wall of one fiber to that of the adjoining fiber. If we can retain them in their original position, I believe it will be possible to isolate them in their microstructural form by removing the other components.

Dr. Mark: I think an experiment is always worth while. Does there exist any substance containing a heavy atom which reacts specifically with the hemicelluloses? If one could stain the hemicelluloses with

a lead salt, it would give a better shadow and in the microscope one could find out something about the distribution of the hemicelluloses in the sample by getting spots. I do not know whether that could be done because I do not know enough about the chemistry of the hemicelluloses but, if a heavy metal could be combined with it, one would be able to discover its distribution in the electron microscope.

S. I. Aronovsky: I would like to say to Dr. Ritter that, in running alpha-cellulose determinations on some agricultural residue pulps, we found that we could not remove the hemicelluloses with mercerizing alkali, even after five treatments. Dr. Sisson in his slides shows fibrils of different lengths. I want to ask Dr. Sisson, do the fibrils in those different materials vary in length with the species of wood or plant?

Dr. Sisson: We have never traced one from beginning to end but they appear to vary in length.

Dr. Siegel: There seems to be a definite difference in these fibrils which ranges from 100 to 350 A in diameter. The ramie fibrils seem much longer and more highly oriented. Wood fibrils are shorter and not so uniformly oriented, and flax fibrils are long but smaller in average diameter. There is a definite indication, however, that wood—in this case, pine—has fibrils which are shorter than those of ramie.

Dr. Aronovsky: What I would like to know is: Does the ultimate size of the fibrils have something to do with the strength characteristics of the individual fiber?

Dr. Sisson: I do not know that this can be answered definitely, but I would guess that there should be a relationship. The longer fibrils should give greater strength since most of the stretch would take place between the fibrils.

Dr. Aronovsky: Do the diameters of the fibrils also have an effect?

Dr. Sisson: Yes.

Dr. Heinig: In the past, it was common to use the optical microscope for studying pulp. Does not work with the electron microscope show the futility of beating? We know specific surface is a large factor; consequently, in order to evaluate the total surface, you have to consider the submicroscopic surface, and does that not rule out the light microscope as a means of evaluating the beating of the pulp?

Dr. Mark: As you have seen, some of the pictures were made with disintegrated fibers. It seems that untreated and treated cellulose behave quite differently if they are disintegrated. In the slides one sees always fibrils which are bundles of chain molecules; that shows that cellulose is of such fibrous character that it always splits into threads and filaments no matter what you do with it.

Dr. Schenck: Dr. Mark mentioned that Dr. Hermans had decreased the percentage of crystalline material by dry grinding. I would like to raise the question whether that might occur in the beating of pulp and, if so, would it have any effect on the fiber bonds in paper?

Dr. Sisson: You have to grind cellulose in a completely dry condition to produce the amorphous x ray diagram. If you do it wet, you get no change in crystallinity. Therefore, I doubt, from the experiments which I have seen, if any pulping operation would produce amorphous cellulose. It is possible that very fine fibrils may be produced which range in size down to such fine particles that they approach single molecules; in this case you would decrease the effective crystallinity.

There is one other interesting thing about dry grinding. If you grind until you get a certain amount of amorphous cellulose and then put the material in boiling water, the cellulose will go back to the native crystalline form. On the other hand, if you grind for a time sufficient to produce a large amount of amorphous cellulose and then put it into boiling water, it will change to the regenerated or mercerized form.

Dr. Gardner: I wonder if Dr. Sisson is referring to air-dried material or real moisture-free material, with precautions to exclude moisture during the grinding process?

Dr. Sisson: I think that it is not necessary to dry to absolutely moisture-free. You can have 1% of water but it cannot have the normal regain at atmospheric conditions.

Dr. Ritter: During the war we did considerable work for the War Production Board, and one of those projects was on the preparation of wood storage battery separators. We developed methods for obtaining separators from different species of wood. The purpose of the project was to find substitute woods for Port Orford cedar. Some of those substitutes had to be treated differently than others to reduce the electrical resistance to an acceptable value. We found that, if the separators were treated so as to get electrical resistance of 0.0010 ohm, and then the separator put into boiling water for 10 minutes, the electrical resistance would rise. I wonder if that phenomenon is related to what we have here. If we can obtain more crystalline material, it would seem that the electrical resistance would be higher than before the heat treatment. Will the real crystalline cellulose offer more resistance to the transmittal of electric current than the amorphous will? Will somebody tell us about that?

Dr. Sisson: Were your measurements made under normal regain conditions?

Dr. Ritter: It was always water soaked but the resistance would rise from 0.0010 to 0.0013 or 0.0014 and it would remain there for quite a while. If the separators were soaked in cold water for several days, the electrical resistance gradually fell to about the value before the separators received the hot water treatment.

Dr. Sisson: Wood pulp with a normal 6% regain goes up to 10% after grinding; when this is soaked in boiling water, the regain is decreased to 7%. In other words, its ability to seal and take up less moisture when treated with hot water may explain your increased resistance to conducting electricity.

Dr. Heath: I'd like to ask Professor Mark regarding Dr. Frillette's work. I notice you always boil the sample afterwards. Is that necessary?

Dr. Mark: No, it is not necessary to boil. At 60 or 80°C., the fringes will also crystallize.

Dr. Heath: Can you simply wash out the sample and get in the same increase in crystallization?

Dr. Mark: Yes.

Burning of Wood Waste in the Pulp and Paper Industry

H. W. BEECHER

An evaluation of hog fuel, particularly as the pulp and paper mills of the Pacific Northwest are affected, is presented together with observations on boiler operation when wood waste is used.

THE FOLLOWING notes apply particularly to the burning of wood waste or so-called hog fuel in the pulp and paper industry in the Pacific Northwest. The location of pulp and paper plants in the heart of a district in which there is a large production of lumber has resulted in the pulp and paper mills importing from sawmills as much hog fuel as they can secure for use in their plants.

This hog fuel is variously transported in trucks carrying from 5 to 6 units of fuel;* in railroad cars of the open box body type handling from 15 to 25 units; and where water transportation is available, in open barges or scows with side boards and having capacities ranging from 120 to 300 units.

Fuel is purchased at the sawmills for prices ranging from 50c to $1.75 per unit depending upon the local competitive market for the sawmill mill waste. The hog fuel is prepared from sawmill trimmings by passing through a hog or grinder and usually is combined with sawdust from the mill, and represents the surplus of waste after the boiler plant requirements of the sawmill have been met. Such hog fuel, if fir, will usually vary from 47 to 52% moisture. If hemlock or spruce, it will vary from 55 to 63% moisture.

Naturally, the available B.t.u. per pound is affected by the moisture content. Hog fuel containing 50% moisture has 1 pound of water per pound of dry wood and therefore requires approximately 1300 B.t.u. absorption from the gases in order to heat this water content to the boiling point, evaporate into steam, and superheat to the outgoing gas temperature.

The moisture content of fuel varies seasonally. The B.t.u. content per pound of dry wood of the various coniferous species is approximately 8900 and does not vary materially between species. The B.t.u. content will vary between samplings of a given species depending upon the amount of pitch or resin in the individual sample of which the B.t.u. content is determined. This accounts for the fact that some authorities give high determinations for each of the common coniferous woods and other authorities quote low determinations. For the general run of power plant calculations, it is believed that an average of 8900 B.t.u. per pound is suitable.

When sawmills operate dry kilns and thus have lower average moisture content in the refuse, the fuel will have higher B.t.u. content per pound but frequently the kiln-dried material is in the form of shavings which have low weight per cubic foot in the measuring container and thus the unit of measurement on which fuel is purchased actually represents a lesser B.t.u. content.

The B.t.u. content of the fuel as purchased and sold on a volumetric basis is also affected by the sawdust content and the thoroughness with which it is mixed with the larger hog fuel chips in the transporting container. Obviously, if the voids between the hog fuel chips can be filled with the finer material a greater weight of dry fuel is obtained per unit. This parallels the situation where almost one-half yard of sand can be added to a cubic yard of gravel and have only a cubic yard of the mixture.

A unit of average hog fuel in boilers of equivalent efficiency will produce a little more steam than 2 barrels of oil will produce, and a little more than half as much steam as a ton of coal (12,500 B.t.u. per pound) will produce. It is therefore evident that there is considerable saving in burning hog fuel rather than oil or coal at present prices of these fuels, within reasonable transportation costs for the hog fuel.

Figure 1 shows roughly the relation between fir fuel, hemlock fuel (with the higher moisture content), oil fuel, 11,000-B.t.u. coal, and 12,000-B.t.u. coal. In each case the boilers are designed for comparable efficiencies in accordance with good practice. With such a chart one can readily compare the costs per million B.t.u. with the various fuels at any selected prices.

In the pulp and paper plants in the Pacific Northwest it becomes necessary to burn oil as a supplemental fuel to the hog fuel because: (1) there may be interruptions in hog fuel supply due to conveyor breakdown or transportation difficulties, and (2) there may not be sufficient hog fuel available to meet the entire requirements. If the latter case prevails it is necessary to make all calculations on relative efficiencies for various plant designs on the basis of the reflected price of the higher cost fuel, namely oil, as any improvement in efficiency in the burning of hog fuel results in a decrease in the quantity of oil required.

Because of the marked increase in fuel oil costs in the Pacific Northwest considerable interest has been exhibited recently in changes that could be made to produce higher average efficiencies in our pulp and paper boiler plants. With the advent of the hydraulic barker has come a big decrease in the amount of available fuel from the wood preparation plant and therefore the need of greater amounts of supplemental fuel. The quality of the wood refuse from the wood preparation plant has also been slightly decreased in that the bark carries the dirt and usually has a higher moisture content.

In eastern and southern districts bark for a long time has been the principal refuse from the wood preparation plant and this bark has been burned with greater ease because it can be reduced to more or less

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* The unit measure for hog fuel is universally taken as 200 cubic feet.

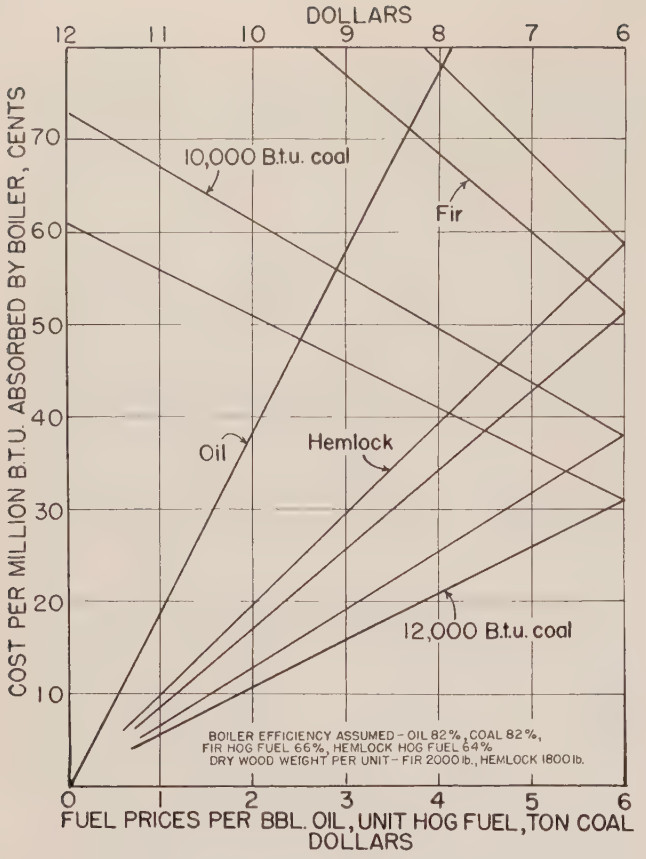
DOLLARS
12 11 10 9 8 7 6
COST PER MILLION B.T.U. ABSORBED BY BOILER, CENTS
70 60 50 40 30 20 10
10,000 B.t.u. coal
Fir
Oil
Hemlock
12,000 B.t.u. coal
BOILER EFFICIENCY ASSUMED - OIL 82%, COAL 82%, FIR HOG FUEL 66%, HEMLOCK HOG FUEL 64%
DRY WOOD WEIGHT PER UNIT - FIR 2000 lb., HEMLOCK 1800 lb.
0 1 2 3 4 5 6
FUEL PRICES PER BBL. OIL, UNIT HOG FUEL, TON COAL
DOLLARS

Fig. 1. Relative costs per million B.t.u. with various fuels at prices indicated

uniform size. In the case of hog fuel the sizing of particles has not been attained, and to resize them or pass the material over a screen and rehog the rejects would represent a comparatively high additional cost per million B.t.u. obtained.

Consideration has been given to the possible use of spreader stokers on hog fuel boilers, but none of the stoker companies has yet ventured to offer this equipment for the type of hog fuel obtained from the sawmills of the Northwest without imposing size restrictions. Experience indicates that there would not be any material advantage either from the standpoint of capacity or of efficiency, in burning hog fuel on stokers, in spite of the claims that may be advanced by stoker manufacturers.

With overdraft, using air and the proper controls, from 20,000,000 to 25,000,000 B.t.u. can be obtained from an 8- by 10-foot dutch oven cell with reasonably wet hog fuel if boiler units include preheated-air and fuel feeders. With dutch oven furnaces excess air can be reduced to approximately the same percentage as with stokers. It is possible to obtain as low leaving gas temperature with dutch oven fired boiler units as with stoker fired. Thus the dry gas and moisture losses will be comparable.

With water-walled combustion chambers the only radiant heat losses that are not common to dutch oven fired and stoker fired units are the radiation losses from the dutch oven, side walls, front wall, and roof. At most, these can be only a fraction of the $1^1/_2$ to 2% radiation losses on a normal boiler unit. The radiation losses from any boiler unit are more apparent than real if the power plant is so designed that such radiation losses merely impart additional heat to the air later used for combustion.

From the above analysis of losses it is apparent that there is very little increased efficiency possible in using stoker firing. The only real advantage attached to the installation of stoker is in those few cases where coal is to be the supplemental fuel and it is not economically feasible to burn this supplemental fuel in separate units from the hog fuel fired boilers. If this means that all of the hog fuel must be subjected to screening and rehogging in order to provide proper sizing, the increased cost per unit resulting from this additional fuel preparation will generally mean that the installation of separate units for hog fuel firing would be warranted.

High temperatures of preheated air (400 to 550°) are desirable when burning high moisture content hog fuel. These high temperatures are not permissible with stokers.

When hog fuel is made from logs that have been transported and stored in salt water, there is sufficient salt in the water to impose a serious slagging problem. The slag which is formed is bonded on the tubes by crystallized salt and will frequently build up in birdsnests that gradually force boiler outage.

With boilers for high capacity and efficiency operation it is necessary to have preheated air and forced and induced draft fans. With the large amount of light cinder carryover it is necessary to enclose between the unit and the fan some means of cinder collection in order that the carbon content may be reinjected into the furnace or combustion space. This is necessary for two reasons: first, the improved efficiency resulting from the catching of carbon otherwise lost, and second, to prevent rapid abrasion of induced draft fan.

Installations have been made in which the cinder collector was located between the boiler and the air preheater. Installations have also been made with the cinder collector located between the air preheater and the induced draft fan. The latter location is to be preferred. It permits the use of smaller cinder collector for a given total draft loss.

It also affects operation in a peculiar manner not normally suspected but detected as a result of experience. If the cinder collector is placed ahead of the air preheater it removes all of the coarse cinders but does not remove the micron sized dust. At the low temperature end of the air preheater there are times at low loads when the gases are below the dew point. When this occurs this fine dust adheres to the surface of the tubes and the bottom of the tube sheet. Once the metal is coated with this fine dust it has sufficient insulating properties to increase the adherence of additional moisture, and these deposits gradually build up until they will actually close air preheater tubes. Cases have been known where it has been necessary to water wash the cold end of air preheater each week in order to keep the unit in service. With the cinder collector located after the air preheater there are sufficient large sized cinders in the gases to scour these surfaces and prevent this accumulation.

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Apparatus for Determination of Polyuronide Carboxyl

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A method is described for the quantitative determination of polyuronide carboxyl groups which is applicable to a wide range of fibrous materials, including woods, purified fibers, and isolated hemicelluloses and pectic preparations. The experimental error is indicated by the standard deviation of 0.099% for a single analysis (based on 86 determinations).

THE FACT that uronic acids and polyuronides yield carbon dioxide quantitatively on refluxing with boiling 12% hydrochloric acid has been made the basis for their estimation by many investigators. The apparatus to be described for application to this analysis has been in use in the Institute's laboratories for several years. It is relatively simple and compact in design and has given uniformly good results in the hands of a large number of analysts.

Although the method is essentially a macro one (*2*), the apparatus was evolved from one designed for the microdetermination (*1*).

The apparatus is shown in detail in Fig. 1. The guard tubes at either end of the train contain Ascarite, backed on either side with Anhydrone. Glass wool separates the materials and serves as plugs for the ends. The long drying tube immediately following the trap is filled with Anhydrone and sealed onto the delivery tube from the trap with Kroenig's cement. The following outside dimensions in millimeters are suitable for the glass tubing used for constructing the apparatus: drying tube 13 to 14, trap 17 to 18, tubing connecting trap with condenser and drying tube 9 to 10.

The absorption tube contains Ascarite as an absorbent for carbon dioxide with a layer of Anhydrone to absorb any moisture released by the Ascarite. The capillary tubes on the ends of the absorption tube are similar to those used on tubes for microcombustions. The tubes are fitted with a loop of nichrome wire so that they may be weighed by hooking on the stirrups of a balance. The absorption tubes are handled only by the capillary ends, and the latter are wiped successively with a moist cloth and a dry chamois each time after removal from the apparatus. When not in use the absorption tubes are stored in test tubes closed with rubber stoppers.

The trap is filled to a depth 5 mm. above the inlet tube with 85% phosphoric acid containing silver phosphate. The solution is prepared by dissolving about 10 grams of silver carbonate in 300 ml. of 85% phosphoric acid, after which it should be heated on a steam bath for 1 hour with a stream of carbon dioxide-free nitrogen passing through the solution to remove carbon dioxide. The solution in the trap is renewed after each determination. The trap can be readily drained, and rinsed with water and refilled by the judicious application of suction at the reaction flask connection. It is necessary to thoroughly wash and clean the trap only after a number of determinations. Phosphoric acid has been found much preferable to sulphuric acid as a trap liquid, because the furfural evolved during the determination chars in strong sulphuric acid with the formation of some carbon dioxide.

The apparatus as described may be applied to any of the usual modifications of the uronic acid method. The following procedure has been in general use in our laboratories.

Tank nitrogen is used as a carrier gas as recommended by Whistler, Martin, and Harris (*4*); the flowmeter is calibrated with a wet-test meter. A safety bottle is provided to insure a constant pressure of nitrogen. Glycerol is used in the heating bath. The 12% hydrochloric acid used for the decarboxylation reaction is saturated with sodium chloride as recommended by Burkhart, Baur, and Link (*1*).

An accurately weighed sample (2 grams of wood meal or pulp or up to 100 mg. of contained uronic anhydride in substances richer in polyuronides) is placed in the reaction flask and 60 ml. of the 12% hydrochloric acid mixture added. The flask is connected to the condenser and the entire apparatus connected as shown in the diagram. Heat is applied to the glycerol bath at such a rate that the temperature is raised to 70° in 20 minutes, and during this time nitrogen is passed through the train at the rate of 1.7 liters per hour. This preliminary treatment serves to flush carbon dioxide from the apparatus and to decompose carbonates in the analysis of plant products, as recommended by Phillips, Goss, and Browne (*3*). The absorption tube is then removed, conditioned in a stoppered test tube near the balance for 5 minutes, and weighed. During this time, nitrogen is allowed to flow through the apparatus while the bath is held at 70°.

The absorption tube is replaced and the bath temperature slowly raised to 137 to 140°C. over a period of 30 to 45 minutes. It is held at this temperature for 3 hours (or longer, if necessary) after which, without stopping the flow of nitrogen, the absorption tube is removed (the connection further removed from the flask is disconnected first). The absorption tube is placed in a stoppered test tube for 5 minutes, then removed, and weighed at once. The gain in weight represents the weight of carbon dioxide evolved which is multiplied by 4 to obtain the equivalent weight of uronic anhydride.

The operation of the apparatus was checked by weighing 100-mg. samples of pure sodium carbonate in gelatin capsules and placing them in the reaction flask after the preliminary flushing at 70°C. The bath was then heated to 137 to 140°C. The results in

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Table I show an adequate rate of removal and recovery of carbon dioxide.

Table I. Recovery of Carbon Dioxide from Sodium Carbonate

Time at 137–140°, min.	*Na_2CO_3 added (as CO_2), mg.*	*CO_2 Recovered, mg.*
15	41.5	40.2
30	41.5	41.0
30	41.5	41.5

The apparatus and procedure have been checked repeatedly with specimens of pure uronic acids and their salts. The results in Table II may be considered typical and were obtained with a sample of pure sodium galacturonate.

Table II. Carbon Dioxide from Sodium Galacturonate

Time at 137–140°, hr.	*CO_2 Calculated, mg.*	*CO_2 Found, mg.*	*Recovery, %*
3	20.4	20.1	98.5
3	20.4	20.1	98.5
4	20.4	20.3	99.5
4	20.4	20.3	99.5

Although a reaction time of 3 hours at the maximum temperature of 137 to 140°C. has been found adequate for most wood and pulp samples, the necessary time for complete evolution of carbon dioxide on a material of unknown type can be determined only by trial. The apparatus described is suitable for rate studies since the absorption tubes can be changed quickly and two tubes alternately used for absorption and weighing.

The use of 12% hydrochloric acid saturated with sodium chloride accelerates the evolution of carbon dioxide from polyuronides presumably because of the elevation in boiling point. At the same time, the values for carbon dioxide evolution from pure sugars which have been found are somewhat above those reported in the literature. Therefore, in some cases the use of 12% hydrochloric acid without sodium chloride may be found preferable.

The precision of the method has been calculated from a total of 86 recent analyses in duplicate. The specimens tested covered a wide range, including woods and other fibrous materials, purified fibers, and isolated hemicelluloses and pectic preparations. The carbon dioxide values ranged from 0.3 to 16.6%. The

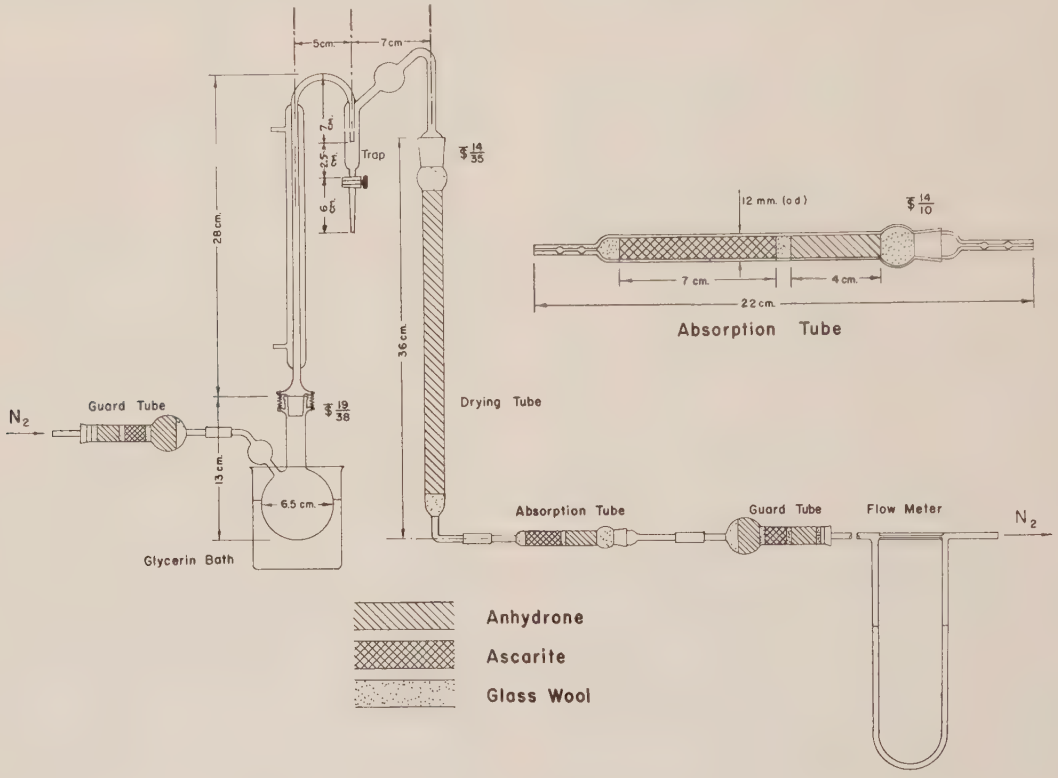

Fig. 1. Uronic acid apparatus

experimental error is indicated by the standard deviation of 0.099% for each single analysis.* The standard error of the average for an anlysis in duplicate is $0.099/\sqrt{2}\% = 0.070\%$. For uronic anhydride, because of the unfavorable multiplying factor of 4, the standard deviation is 0.40% and the standard error is 0.28%.

* The standard deviation is found as

$$s = \sqrt{\frac{\Sigma(x_1 - x_2)^2}{2n}}$$

where x_1 and x_2 are the duplicate observations in the analysis of one specimen and the summation is over all n specimens.

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TAPPI Survey of Paper Coating

Review of the Literature for 1946

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The literature on paper coating for 1946 is discussed in this report. The subject matter is divided into three principal classifications, as follows: coating for printing papers, consisting usually of pigment-adhesive coatings in aqueous media; protective coatings composed largely of resins or other film forming ingredients (solvent or aqueous vehicles may be present); and specialty and miscellaneous coatings. For convenience the material is also divided into subdivisions such as pigments, adhesives, equipment, testings, and packaging. A numerical patent index and an author index are given.

THIS SURVEY, sponsored by the TAPPI Coating Committee, is similar in arrangement and content to the initial survey prepared for the year 1945, which appeared in the *Paper Trade Journal* of August 15, 1946. There was an unavoidable delay in preparing the present review, but it is hoped that the reports for succeeding years will be completed more promptly.

Although the literature references cited cover the field fairly extensively, the list is by no means complete and is limited largely to United States publications with a few English and Canadian articles being included. Only U. S. patents are covered, with a few exceptions.

The subject matter is divided into three principal classifications, as follows: (a) coatings for printing papers, consisting usually of pigment-adhesive coatings in aqueous media; (b) protective coatings composed largely of resins or other film-forming ingredients (solvent or aqueous vehicles may be present), and; (c) specialty and miscellaneous coatings. These classifications often overlap.

PRINTING PAPER COATINGS

With the end of the war, problems of the paper coater did not appear to diminish, at least as rapidly as expected.

General

Olmsted (*1*) outlines the general production and supply situation with regard to book paper. Increased demand coupled with a shortage of pulp and adhesives has affected the supply of coated paper. Shortage of casein and other factors has been especially serious in the case of litho label paper. Rundell (*2*) surveys the future of coated papers for letterpress printing. Marked growth and improvement of machine-coated papers are predicted. Characteristics of the various grades of book paper are described in another article (*3*), and the important factors in choosing a paper discussed. Putois (*4*) describes the manufacture and various types of printing and fancy coated papers in Europe.

Announcement of expansion in coated paper capacity indicates current major trends in the direction of increased machine coating capacity and various process improvements with the objective of more economical operation. At the Bryant Paper Company (now St. Regis), Kalamazoo, Mich., a new coating plant is being built, with no details given as to the type of machines; a Graphic Arts laboratory is described, a joint enterprise of the paper company with Time, Inc. (*5*). The International Paper Company plant at Palmer, N. Y., has been licensed to make machine-coated paper by the Consolidated process (*6*), and in the same announcement a review is given of other proposed and existing installations of Consolidated machine coating equipment.

Pigments

Particle size and other data based on electron microscope and supplementary procedures are given by Tilleard and Smith (*7*) for clay, titanium dioxide, lithopone, ultramarine, and other pigments. The work is directed toward paint pigments, however, and comprehensive studies of the same sort covering paper coating pigments would be a welcome addition to the paper coating literature.

General reviews of the nature, mining, properties, and uses of clay in the paper industry, primarily based on British practice, are given by Robertson (*8*), and Johnstone (*9*). Fundamental studies of the properties of clay have been reported by Mukherjee and Mitra (*10*), Kocatopcu (*11*), and Laws and Page (*12*). Lyons (*13*) discusses properties of paper coating clays with regard to such important properties as particle size and its effect on coating color viscosity.

A fairly complete discussion of the properties of calcium carbonate with reference to its use in paper coating is given by Brooks (*14*). A patent issued to Mowlds (*15*) describes the use of a pyrophosphate as a dispersing agent and stabilizer in calcium carbonate-protein coating composition. It is claimed that higher solids contents can be obtained, and that reaction between the pigment and protein is reduced, giving less discoloration.

Haywood (*16*) discusses the preparation and properties of calcium sulphite as made specifically for paper coating. This pigment is new to paper coaters,

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but has interesting properties. A patent issued to Haywood and Welton (*17*) covers the preparation of calcium sulphite.

Blount (*18*) reviews the nature, production, and properties of talc which is used as a lubricant in the manufacture of friction and flint glazed papers. Stubbs (*19*) discusses the use of Calgon (sodium hexametaphosphate) and tetrasodium pyrophosphate as pigment dispersing agents in starch- and casein-pigment coatings.

Adhesives

Smith (*20*) and Brother (*21*) review the nature, properties, and uses of proteins, including casein, with regard to paper coating and plastics. Morgan (*22*) describes the use of an alkyl branched-chain fatty acid to plasticize corn protein coatings, either clear or pigmented. An extensive survey of the literature and patents covering the use of zein for various types of coatings has been prepared by Collins (*23*). A method of treating soybean protein to obtain a paper coating adhesive of improved color, involving the use of sulphur dioxide and sodium hydrosulphite, is described by Youtz (*24*). A casein laminating adhesive is made more resistant to water and fungus attack by incorporating an ammonium or amine complex compound of zinc, cadmium, or magnesium, according to Ware (*25*). Eilerman (*26*) describes the use of hydroxylated organic acid amides to plasticize and reduce the viscosity of casein films and coatings. Dunham (*27*) describes a method of purifying soybean meal for use as a paper coating adhesive.

Continuing growth and progress with regard to the use of starch as a coating adhesive are indicated by the numerous articles and patents. A panel discussion of starch (*28*) covers such subjects as the use of urea-formaldehyde and melamine-formaldehyde to improve water resistance, and various extenders for augmenting the supply of starch. Casey (*29*) presents a general summary of the importance, uses, economics, and future of starch in the paper industry. Technical developments and problems in the coating field are discussed.

Kesler, Killinger, and Hjermstad (*30*) present interesting results covering studies of moisture sorption and film shrinkage of starches and other coating adhesives. Starch treated with urea-formaldehyde resin exhibits a minimum film shrinkage and has many desirable properties for the production of paper coatings. Landes (*31*) describes the use of urea and melamine resins in starch-pigment coatings for paper suitable for offset printing. Other important factors mentioned include pH control, use of suitable pigment dispersing agents, and the incorporation of wax emulsions to improve printing results. Another article (*32*) mentions briefly the use of urea resins in starch-pigment coatings.

Craig (*33*) describes a method of preparing high-solids pigment-starch coating compositions in which the raw starch, pigment, water, and enzyme are cooked together under conditions suitable for obtaining the usual enzyme action. Coating compositions up to 70% solids can be prepared. Radley (*34, 35*) gives complete summaries of the manufacture, nature, properties, and uses of waxy starches and the starch esters and ethers.

Several special starch compositions have been patented. Glarum and Thomas (*36*) describe a stabilized starch paste containing urea-, melamine-, or urea-melamine-formaldehyde condensate. Gill and McDonald (*37*) obtain a starch paste of increased viscosity by treating raw starch with dimethylol urea or trimethylol melamine under specified pH and other conditions. Evans (*38*) claims a nongelling starch composition is obtained by the incorporation of an alkylolamine soap. Bauer, Bauer, and Hawley (*39*) describe the preparation of a special starch which swells in cold water without individual particle identity being lost, and claimed to be useful for coating.

Miscellaneous Materials

Products useful in plasticizing proteins are described by Bruson (*40*), based on condensates of aliphatic polyhydric alcohols and an unsaturated nitrile such as acrylonitrile. Kirk (*41*) describes the preparation of a silicic acid sol that is suggested for various uses including the treatment of protein-pigment coatings to improve water resistance. Blumenthal (*42*) gives a comprehensive review of the chemical and physical nature, and methods of preparation, of color lakes.

Coating Compositions and Processes

Clark (*43*) describes a method of making a high gloss coated sheet using calcium carbonate as the pigment. Heritage and Walter (*44*), and Heritage (*45, 46*), give various formulas for coatings to be applied to undried insulating board.

Equipment

The trends toward high speeds for coating on the paper machine, and off-machine coating, are well illustrated by several articles and patents. Egan and others (*47, 48, 49, 50*) describe two Waldron coaters, one an air jet type and the other an offset rotogravure type. Advantages of machine coating and factors in designing the equipment are discussed briefly. Equipment patents issued include those of Muggleton and Piepenberg (*51, 52*), Harrigan (*53*), Dieckbrader (*54*), Barrett and Asdell (*55*), and Barrett (*56*).

A discussion of the mechanics of supercalendering and of operating factors in calendering machine-coated paper is given by Thomas (*57*).

Quality and Testing

The familiar theme of printing troubles and the properties desired in printing papers is discussed in one article (*58*). Beadie (*59*) gives specific qualities and properties required of coated paper for offset printing. Griswold (*60*) presents an interesting and practical digest of the frank opinions of lithographers as to what is wanted in coated papers. Another interesting and stimulating analysis of ink-paper relationships in lithographic printing is made by Frost (*61*).

The problem of eyestrain as related to paper and printing is discussed by Fishenden (*62*). Reed (*63*)

presents an authoritative and comprehensive analysis of the causes and remedies for the curling of lithographic papers.

Several interesting articles have appeared covering the evaluation of printing properties of paper. Voet and Brand (*64*) describe a method of determining the speed of ink penetration and indicate the importance of ink vehicle fluidity. Vallandigham (*65*) describes a method of determining the oil absorption rate of paper and claims correlation between absorption rates and printability using various types of ink and paper. Buchdahl, Polglase, and Schwalbe (*66*) present an interesting approach to the desirable objective of obtaining a quantitative evaluation of printability. Buchdahl and Polglase (*67*) describe two novel methods of measuring ink coverage and film thickness.

An interpretation by Buchdahl and Thimm (*68*) of the working properties of a printing ink in terms of its rheological properties may be of interest with regard to coating colors. A new method of quantitatively determining the bonding strength of paper, particularly coated paper, is given by the Institute of Paper Chemistry (*69*). It is hoped that further investigation of this important problem, and of the interesting leads obtained with regard to various coating and printing phenomena, can be reported soon.

PROTECTIVE COATINGS

The greater availability of plastics and resins for paper coating, and the increasing interest in coated and laminated papers for packaging and other uses, are well depicted by the current issues of the *Modern Plastics* and *Modern Packaging Encyclopedias* (*70, 71*). These excellent volumes provide an amazing amount of general and technical information of interest to paper converters.

Among articles of general interest is one by Mosher and Bracewell (*72*) in which the various types of coatings and impregnating materials for imparting "functional" properties to paper are described. Mosher (*73*) discusses the various methods of treating paper to be used for decorative and protective packaging. Mosher (*74*) also describes the various methods of treating paper with synthetic resins on the paper machine. Specialized coatings are discussed by Graebner (*75*).

Raw Materials

Some of the desirable properties for paper used as the base stock for impregnating are described by Perry (*76*). Scofield and Edwards (*77*) provide a helpful list, by trade names and types, of about 800 resins sold primarily to paint, varnish, and lacquer manufacturers. Morgan (*78*) reviews the uses of resins and plastics in connection with paper. The good and bad features of various types of synthetic films for packaging food are reviewed by Hanmer (*79*). Recent trends in synthetic film-forming materials and methods of application are discussed by Hewitt (*80*).

The combining of paper and plastics is discussed by Sands (*81*). The packaging qualities of the new plastic films are described by Aiken (*82*). A review of laminating adhesives by Biddle (*83*) gives the good and bad features of many types of laminants, and important points with regard to their application.

Interesting developments in vinyl resin coatings are reported by several authors. Quarles (*84*) reviews the properties and uses of vinyl resins, including the new type of dispersion termed organosol. Hoyt (*85*) and Moulton (*86*) give detailed descriptions of organosol and plastisol coatings. These polyvinyl chloride dispersions offer many advantages with regard to application of coatings for packaging papers. Stanton and Henson (*87*) describe the properties and uses of Saran coating latex, another interesting coating material.

Another article (*88*) describes the hot melt application of polyethylene to paper to provide a water vapor resistant and heat-sealable coating.

Penn (*89*) discusses the properties and uses of the allyl ether of starch. Other materials useful as protective coatings that have already been mentioned are starch esters (*35*), the waxy starches (*34*), and zein (*23*). Penn (*90*) also describes the use of carboxymethycellulose for greaseproof coatings.

The properties and uses of microcrystalline waxes and petrolatum are covered by Clary (*91*) and Rhodes (*92*). A new type of material, the silicones, is described generally by McNabb (*93*). One of these gives a thin, resinous film on paper fibers, and provides good water resistance. Metal soaps are mentioned as being useful in waxy coatings for paper by Downie (*94*).

A number of patents covering various types of resins claimed to be useful in coatings have been issued. Modified rosin and terpene products have been covered by Rust (*95*), Auer (*96*), and Rummelsburg (*97*). Hersberger (*98*) reacts a hydrocarbon oil with an aldehyde and polycarboxylic acid. D'Alelio (*99*) describes a copolymer of an unsaturated alkyd and a vinyl compound. Harmon (*100*) describes a complex polyamide type of adhesive coating material. Rothrock (*101*) prepares a resin by reacting a polyhydric alcohol with an aldehyde such as acrolein. Unsaturated carbonate ester polymers are described by Muskat and Strain (*102*) and Pollack (*103*).

Coating Compositions

A new type of coating, called a gel lacquer, consists of a gel of cellulose acetate-butyrate in a mixture of solvents (*104*). Brown (*105*) gives details of a vinyl resin-pigment type of coating in solvent solution for protecting maps and charts.

The interest in *hot melt* coatings is emphasized by the numerous patents in this field. Cellulose derivative coatings are described by Salo and Vivian (*106*), McDowell (*193*), and Salo (*107, 108, 109*). Noble (*110*) describes a paper coating or adhesive containing stearic acid, ethyl cellulose, and wax. May (*111*) prepares a thermoplastic coating for cans by milling together a naphthene polymer and polyisobutene. Coatings or laminants containing wax and metallic soaps have been patented by Massey and Burgess (*112*), Burgess and Abson (*113, 114*), and Berliney,

Bowden, and Hohnstine (*115*). Formulations for cyclized rubber compositions are given by Carson (*116*).

Coating compositions applied as *solvent solutions* include those of Witty (*117*), Quick (*118*), Powell (*119*), May (*120*), and Dreyfus (*121*). Corn protein compositions are described by Morgan (*22*) and Hagemeyer (*122*).

A polyethylene composition for hot calendering on to paper is described by Alderson (*123*). A polyamide emulsion containing a high boiling alcohol is disclosed by Leekley (*124*).

Equipment and Processes

A review of the history, methods, and problems of waxing paper is given by Ferguson (*125*). The development of an automatic labeling machine for applying labels coated with a thermoplastic adhesive is described (*126*). The adhesive used has several unusual properties including delayed tack, and this development appears to have many potential advantages.

A brief description is given of an electrostatic process for applying cut fibers to a backing sheet coated with an adhesive (*127*). Rappolt (*128*) mentions various kinds of heating operations required for certain types of coatings such as hot melts. A hot spray method of applying a plastic material such as shellac to paper is presented by Murty (*129*).

Equipment and procedures for applying thermoplastic coatings to paper are described by Grupe (*130*) and Nordquist (*131*). Other devices include those of LaHatte and Smith (*132*) for applying carbon coatings, Bergstein (*133*) for lacquer application, Rowe and Goepfert (*134*) for applying abrasive grains to paper coated with adhesive, and Bailey (*135*) for coating labels and wrappers with adhesives.

Packaging

Interest continues to grow in the application of coated and laminated papers for the packaging of foods and other commodities, with the emphasis on peacetime uses and problems.

Elder (*136*) discusses the physical chemistry of odor transfer in packaging materials. Howells (*138*) evaluates plastic dip coatings and finds room for improvement. The fragility and water vapor resistance properties of a number of packaging materials used as carton liners are studied by Lavers and Pearce (*139*). The requirements for case liners are given by Scribner, Carson, and Weber (*145*) and Hardy (*137*). Important investigations in the food packaging field are reported by Metcalf, Van Eseltine, and Hucker (*140*), and Rabak and Stark (*141, 142*). Mathematical equations for indicating the shelf life of water-sensitive packages are developed by Oswin (*143, 144*).

A general discussion of the problems and materials of packaging is given by Speyer (*146*). An interesting development (*148, 183*) involves the use of resin-coated fiber plates and coated bags for frozen dinners that need only to be heated before serving. Toof (*149*) describes an improved container for bulk shortening. Waring (*150*) reviews the development and use of grade A and C greaseproof papers for packaging metal parts. Another article covers the packaging of bearings (*154*).

Basic studies of the packaging of bulk vegetables and dehydrated foods are presented in a series of papers by Brooks, Thomas, and Hucker (*147, 152, 153*). The important factors in packaging frozen meat are given by Ziemba (*155*).

Maier (*186*) suggests a top coat of vinyl resin over the usual varnish coating on paper closure facings, to prevent imparting the varnish flavor to food. Borden and Karlson (*175*) incorporate a dialkyl dichlorosuccinate in hot melt or lacquer coatings to prevent growth of molds and fungi in a packaged food such as bread.

Coatings useful in preventing the adhesion of packaged materials of a tacky nature to the container, or of adhesive on tape to the back of the tape, are described by Srere (*179*), Kellgren and Hurd (*180*), Knoth and Pavlick (*181*), Mitchell (*182*), and Manor (*187*). Cowen (*188*) discloses a coating for paper or cellophane for packaging cheese. Cheyney (*189*) discloses a double coating of vinyl resins for imparting water vapor resistance to porous paper.

Quality and Testing

Important developments in the testing of paper for water vapor and gas permeability are presented by the Institute of Paper Chemistry (*156, 157, 158*), Carson and Worthington (*159*), Davis (*160*), the Packaging Institute (*161, 166*), and Southwick (*162*). Blocking resistance test methods have been published (*163, 164*). A Packaging Institute standard test procedure covers heat-sealing strength (*165*).

Sanborn (*167*) suggests a sanitary code of interest to paper manufacturers and converters. Test methods are given for the bacteriological standards.

Chemical methods for the identification of urea, melamine, sulphonamide, and polyamide resins are given by Kappelmeier (*168*).

SPECIALTY COATINGS

Lesser (*169*) gives a comprehensive review of materials, formulas, application, and properties of carbon paper coatings. A novel wrinkle finish is described (*170*), consisting of two synthetic rubbers compatible at one stage but which separate into two phases on drying. Boughton (*171*) describes an improved coated photographic paper, the body stock containing a melamine resin colloid and an aluminum salt of a monobasic acid.

Patents have been issued covering novel types of paper to Kline and Mobius (*172*) for a conductive paper containing aluminum flakes, a glycol stearate, and a color changing material, to Foote and Guertin (*173*) for a sheet useful for secret documents, and to Littman and Klotz (*174*) for paper treated with a preservative compound including metallic naphthenates.

Flame-resistant resin compositions for coating purposes are described by Kauth (*177*) and Timmons (*178*). Coatings of interest to the homemaker include a decorative and protective resin composition described by Dickinson (*176*), as well as a plastic-impregnated wallpaper (*184*) and a vinyl-coated resin-impregnated stretchable paper useful as a shelf covering, table cloth, and other purposes (*185*).

Special laminated sheets include those of McGarvey (*190*) involving the use of a rubber or resin and cement, and Southwick (*191*) in which heat-sealing adhesives are employed for making bags. Toland and Bassist (*192*) describe treatment of a sheet suitable for use as a lithographic printing plate.

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Editor's Note: Because of the scope of the project and the change in the publication policy of the Technical Association the publication of this report was unavoidably delayed. It is hoped that a similar survey for 1947 will appear in an early issue, however, it is to be noted that the Coating Committee will present only such references as pertain to the production of coated printing papers in its 1948 report. A protective and specialty coating literature survey for 1948 will be prepared by the TAPPI Plastics Committee.

Microorganism Control in Mechanical Pulp and Its Relation to Paper Manufacture

STANLEY J. BUCKMAN

Information is presented in support of the conclusion that the growth of microorganisms in wet mechanical pulp (50% moisture content) can be economically controlled for a storage period of one year or more by treatment with BSM-11B which is a 10% solution of phenylmercuric acetate. The treatment was added to the white water with the system closed so that very little white water was discharged. Slime control was achieved throughout the pulp system by the combined effect of the treatment and operation at a temperature of about 55°C. The other advantages of operation at higher temperatures thus were realized without a sacrifice in pulp quality. The importance of microorganism control in mechanical pulp from the standpoint of the losses caused by slime in paper machine operations is emphasized particularly from the standpoint of pulp stored as slush stock in storage tanks, and as wet sheet or lap stock. The loss of fiber in badly decayed pulp, the difficulty of dispersing partially decayed pulp, and odor as well as darkening in color caused by the growth of microorganisms are all factors which cannot be ignored. However, the major losses result from the contribution of the infection in the pulp to the growth of slime throughout the paper machine systems. The primary general classes of losses caused by slime in paper machine operations are: lost production time; decreased equipment performance; loss of heat, fiber, water and various chemicals; decreased equipment life, particularly felts; and loss of finished product. The more important individual components of these losses are briefly reviewed and information is presented on methods for their evaluation including a unit for measuring the rate of slime accretion in paper machine systems.

As PULP leaves the stone in hot grinding operations it is sterile or at the most contains very few living microorganisms. However, it is infected early in the process primarily by white water carrying living microorganisms which were originally introduced into the system from the fresh water and the air. The amount of infection carried by the white water is influenced predominantly by the temperatures maintained at different points in the system, the degree to which microorganism growth covered by the general term "slime" is allowed to accumulate throughout the pulp system, and the nature of the growth.

The losses caused by the growth of microorganisms in hot grinding pulp operations alone usually are a minor part of the total which ultimately result from the production and use of heavily infected pulp in the manufacture of paper. Many factors influence the magnitude of the total loss which, for comparable conditions, increases in general with the duration of the storage period of the pulp between manufacture and use. This may vary from only two or three hours in a chest, when the pulp slush stock is continuously used in the manufacture of paper in the same mill, to storage as slush stock for one week or more in storage tanks or chests. Although the latter condition usually presents a fertile environment for the growth of microorganisms, a more favorable condition usually occurs when wet lap or sheet stock is stored for periods of several months to one year or more.

In 1925, Kress *et al.* (*21*) reported the results of the first extensive study of the preservation of wet pulp with a review of the limited earlier work of Wolesky (*40*), the concurrent investigation reported by Bates (*3*), and earlier literature containing general information of interest. During the course of the work, 112 different chemicals were investigated and their preservative properties were evaluated. The study included tests of potential preservatives under both laboratory and mill conditions. In addition a systematic study was made of pulp-inhabiting fungi found in samples of pulp submitted from mills in New York, Wisconsin, Minnesota, and Canada. About half of the species isolated were later included in a series of tests to determine the physical and chemical properties of groundwood pulp deteriorated by specific fungi in pure cultures. Although more effective chemical preservatives have become available in the meantime, the comprehensive study by Kress *et al.* remains as an important contribution to the basic information available on pulp preservation.

The work of Kress and his associates was followed by a number of studies related to microorganism damage of wet mechanical pulp, particularly in Scandinavia. Melin (*23*) and Melin and Nannfeldt (*24*) in Sweden suggested the possibility of adding antagonistic microorganisms to the pulp as a means of controlling blue staining fungi. The action of the antagonistic microorganisms was attributed to the secretion of the growth-retarding and growth-suppressing substances which experiments showed were not heat stable. Recently Gadd (*16*) has reported the results of some experiments indicating antibiotic poisons may not be the primary antagonistic factor under some conditions. This worker offers evidence of antagonism as the result of competition for nutritive substances in mechanical pulp which is normally quite low in nitrogen and phosphorus. As Gadd mentions, antagonism in the form of competition for nutritive substances is not necessarily an alternate hypothesis to antagonism arising from the secretion of antibiotic poisons. On the contrary, it seems probable that both types of antagonism may exist simultaneously in groundwood pulp to a varying degree depending upon the conditions involved. All of the general work in the field of antibiotics certainly supports the predic-

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tion that one important competitive factor influencing the growth of the mixed flora in mechanical pulp is the secretion of materials by some of the organisms which retard the growth or even kill some of the other organisms. Moreover, Pehrson (*26*) has recently isolated and studied a bacterium which secretes a heat-stable antibiotic substance. Tests have shown that growth of the bacterium on the same culture with a number of other fungi results in substantial inhibition zones. A number of blue staining fungi and molds as well as pulp decaying fungi were found to be inhibited by the bacterium. A broth culture of the bacterium sterilized by steam also was found to kill *Pullularia pullulans* when added to a broth culture of this organism. Although much work remains to be done before the practicability of biological control of microorganisms in mechanical pulp can be determined, the work of Pehrson (*26, 27*) has justly revived interest in Melin's early discovery.

Rennerfelt (*32*) presented information in support of the conclusion that the growth of fungi in the pulp is influenced by the prior handling of the wood. When all or part of the wood was fresh, it was found that the pulp was attacked more rapidly by fungi than when the wood had been floated. Bade (*4, 5, 6*) in Norway, and Englund (*11, 12, 13*) in Finland, found that mechanical pulp produced in systems operating above 50°C. (122°F.) was considerably more susceptible to damage by decaying fungi. Rennerfelt (*30*) also found that pulp which has been frozen was attacked quickly after thawing, particularly by blue staining fungi, and this has been confirmed by general industrial observations. As has been suggested by a number of workers, it seems that changes in the composition of the microflora in pulp systems operated at different temperatures are very likely responsible for a major portion of the differences in microorganism damage encountered in subsequent storage under equivalent storage conditions. Other factors, such as changes in oxygen resulting from peculiar changes in the volume of bales, may have a bearing on the results observed when bales freeze and thaw. However, as Rennerfelt has noted (*36*), changes in microflora during extended period of storage in a frozen state also can well be responsible for the results which have been observed. Changes in the relative proportions of different groups of antagonistic organisms may markedly change the rate at which pulp damaging organisms develop.

The recognized effect of higher manufacturing temperatures, particularly above 50°C. (122°F.), in causing a greater incidence and severity of decay in mechanical pulp has resulted in many mechanical pulp mills operating at lower temperatures. However, this step has only lessened the amount of damage of pulp by microorganisms. A continuing need has existed for more effective preservation. In addition, it would be desirable to close pulp systems further and operate at higher temperatures thereby obtaining advantages from the standpoint of production costs and pulp quality which are reviewed later in this paper. With the exception of the interruption by World War II, search thus has continued for more efficient preservatives (*6, 7, 8, 11, 12, 13, 19, 24, 29, 31, 33, 34, 35*). Attention also is being given to other potential methods of protecting wet mechanical pulp, such as the previously mentioned biological control method and the work being done in Finland on partial drying of groundwood pulp (*17*) which has followed the earlier unsuccessful attempts to protect pulp by sterilizing it through heating (*1, 13*).

The information presented in this paper on pulp preservation was obtained from cooperative tests at Munksunds Aktiebolag, Lulea Trämassefabrik, Lulea, Sweden. The primary purpose of the study was to determine the degree of protection of wet mechanical spruce pulp provided by different concentrations of BSM-11B, a 10% solution of phenylmercuric acetate, when the toxicant was added to the white water with the system closed so that very little white water was discharged. Although there are references to a prior similar general method of approach (*6, 7, 34*), it is doubtful that the system was closed to the degree attained at Lulea Trämassefabrik and the prior tests were not made with the phenylmercuric compounds used in BSM-11B. There thus was no prior background of experience which was directly applicable. In contrast to the conventional approach of applying a water solution of the preservative to the pulp by means of rollers or sprays or a combination of both just before the pulp is cut into sheets or folded into laps, the method employed at Lulea seemed to offer the following potential advantages:

1. Slime control in the pulp system in addition to preservation of the mechanical pulp. This results in a reduction in the degree to which the pulp is infected as it leaves the system, reduces some of the labor involved in cleaning slime from the system at periodic intervals, and may result in a somewhat improved operation of screens and thickeners.
2. A more uniform distribution of the treatment throughout the pulp.
3. No increase in the weight of the pulp and, in fact, the higher temperatures provided by closing the system should result in greater water removal by the wet machines. This is in contrast to an increase of about 4% in the water content of the pulp when solutions are applied in the conventional manner to the pulp sheets as they are leaving the sheet forming machines (*35*).
4. A greater recovery of fiber and a smaller use of fresh water.
5. Certain additional advantages which have been reported for operation at higher pit temperatures, such as increase in grinding rate, decrease in power consumption, increase in fiber length and freeness, and increase in strength of the pulp (*37, 38, 39*).

METHODS AND MATERIALS

Untreated Controls

Control samples of untreated pulp were taken on Saturday, Sept. 20, 1947, from the regular plant production. A description of the samples taken and the procedure which was employed in their subsequent examination is given in the following under appropriate headings. The pulp system had been well cleaned the prior Sunday by the unusually thorough wash-up and brushing procedure employed in this plant. However, there had been a substantial growth of slime in the system during the week and a layer of slime was

evident on the walls of the channels, white water tank, etc.

Preliminary Clean-Up

All of the pulp was removed from the system and it was thoroughly washed and cleaned with high-pressure hoses and brushes. The system, exclusive of the thickener chest, then was filled with fresh water and the following amounts of chemicals added to the total water supply of about 150 cubic meters after they had been dissolved previously in wooden barrels:

200 kg. (440 lb.) of trisodium phosphate
80 kg. (176 lb.) of sal soda
117 kg. (257 lb.) of BSM-11B

There was no provision for heating the cleaning solution and it was circulated for 2 hours at a temperature of about 13°C. (65°F.) throughout all of the system except the thickener chest. The solution then was pumped to the thickener chest where it was allowed to stand for 2 hours before being discharged to the sewer. Finally, the system was flushed again with fresh water which also was discharged to the sewer and the system was partially filled with water for the start of operations at 22:00 o'clock (10:00 p.m.) on Sunday, Sept. 21.

Treatment

It was originally intended to employ a rapid chemical method for control of the concentration of phenylmercuric acetate in the white water since it was planned to change the concentration three times during a period of one week and accurate feeding equipment, such as a feeding pump, was not available to feed the toxicant into the system. However, it was found that the rapid method of analysis did not yield reliable results in the presence of interfering substances which were encountered in the closed white water system. Consequently, approximations were made and the first two lots of pulp were treated with concentrations which were intended to be about 100 and 400 parts of BSM-11B per million parts of water in the pulp. This was in comparison to the original plan of treating these two lots of pulp with about 100 and 200 parts per million parts of water in the pulp. In addition, the last lot of pulp, 444, was deliberately treated with a considerably higher concentration of the toxicant than originally intended. As noted in a footnote in the following, 10 kg. of BSM-11B were added directly to the thickener chest about ten minutes before the start of production of the group of bales identified as 444. This was done to insure obtaining one group with a high retention of preservative without the necessity of a larger addition to the system as a whole. It was realized that the degree of adsorption of the toxicant by the pulp would largely determine the retention of the preservative by this group of bales. Moreover, the addition of the toxicant to the thickener chest did not insure as uniform a distribution of the preservative throughout the pulp as the addition to the white water employed for the treatment of groups 111 and 222. It also was realized that the method of addition would result in a more or less progressively decreasing retention of the preservative from the first to the last bale in the group. Consequently, one sheet of pulp from each bale in the 444 group was retained for chemical analysis. The chemical analyses of these sheets from each bale in group 444 and a composite sample of small squares from two sheets of each bale in each other treated group were made using the method described in the Appendix. This method is a modification developed by Meals (*22*) from the methods described by Fischer and Leopoldi (*14*) and the Association of Official Agricultural Chemists (*2*).

Samples and Subsequent Handling

Twenty-four untreated bales of about 168 kg. (370 lb.) each and 24 bales produced while each different concentration of preservative was maintained in the white water were retained as sample groups. The untreated group of bales and the treated groups were identified with the following numbers stamped on each bale at several different places:

	Date produced	*Identification no.*
Untreated bale	Sept. 20, 1947	000
Treated bales	Sept. 22, 1947	111
Treated bales	Sept. 26, 1947	222
Treated bales[a]	Sept. 26, 1947	444

[a] As a supplement to the addition to the white water, 10 kg. of BSM-11B were added directly to the thickener chest about ten minutes before the start of production of this group of bales to insure obtaining one group with a high retention of the preservative without the necessity of a larger addition to the system as a whole.

Two bales from the untreated group and two bales from each treated group were stored inside the pulp mill in a warm place and were covered with a canvas to prevent excessive drying during storage. The surrounding floor also was sprayed with water occasionally as a further step to avoid excessive drying. On Nov. 3, 1947, one of the two sample bales from each group inside the pulp mill was opened and the condition of 100 sheets from the central portion of each bale classified. The 100 sheets from each group were marked with a red crayon to identify them when they were removed from the bales. The sheets then were placed on a clean surface while they were examined after which they were returned to the original bale. The bale then was fastened together tightly and returned to its original storage position in the groundwood pulp mill. Examination of the same 100 sheets from one bale of each group was repeated later on Feb. 4, 1948, after which the sheets were returned to the bales where they were allowed to remain undisturbed until July 13, 1948, when they were re-examined. On the last date, an examination was made of the sheets in the one bale in each group which had not been opened previously.

Twenty-two of the bales from the untreated group and each treated group were stored as a unit in magazine No. 1. Twenty sheets from each of two bales in each group stored in the magazine were "streaked" diagonally across the surface with a brush wet with a nutrient solution containing 2 grams of ammonium chloride (NH_4Cl) and 0.2 gram of potassium dihydrogen phosphate (KH_2PO_4) per liter of water. These sheets then were marked with the letters "NP" and a corner was torn from each for further identification after which they were returned to the original bales.

On July 13, 1948, one of the bales from the untreated group and one of the bales from each treated group which contained sheets streaked with the solution of

ammonium chloride and potassium dihydrogen phosphate were opened for preliminary examination. Some of the bales still were partially frozen. There was some evidence of attack by microorganisms in the untreated bale, and the bale from the 111 group. However, it seemed distinctly desirable to postpone the inspection of the remainder of the bales until there was an opportunity for the rapid development of growth of microorganisms which usually occurs soon after frozen bales thaw. The inspection of additional bales therefore was postponed until Aug. 15, 1948. At that time, 10 bales from the untreated group and 10 bales from each treated group were examined with the inclusion in each group of the remaining bale containing 20 sheets which had been streaked with the solution of ammonium chloride and potassium dihydrogen phosphate. The remaining bales from each group were allowed to remain in the magazine where they will be stored for about another 12 months and examined.

During the production of the untreated and treated groups of bales two sheets were taken from each of the 24 bales in each group and eight small samples about 5 cm. square were cut from each sheet. These were placed in separate glass jars equipped with tightly fitting covers and a rubber seal. Eight sets of samples thus were prepared to provide the different cooperators and observers with samples which they could examine as desired and to provide composite samples for chemical analyses as mentioned in the foregoing.

Characterization of Condition of Pulp

For the intermediate inspections of sheets from one bale of each group stored inside the pulp mill on Nov. 3, 1947, and Feb. 4, 1948, the designated number of sheets were examined. A general estimation was made of indications of decay and the percentage of the area of the sheets which showed blue stain or mold. When the inspection was made on Feb. 4, 1948, representative sheets and portions of sheets were forwarded to Buckman Laboratories, Inc., Memphis, Tenn., where they were photographed with black and white film to provide a photographic record of the interim condition.

The final inspection on Aug. 15, 1948, included the bales stored inside the pulp mill which had only been opened once previously and the bales stored inside the magazine which had not been opened previously. The plan followed in classifying the condition of the pulp is one which has been employed by Bade in Norway. This plan is presented in Table I which gives the identifying number and a description of the condition represented by the number. The description is expressed in terms of the normal attitude of users of pulp up to the present time. The limitations of exact statements in this respect are recognized. One number was recorded for each of 10 bales examined from each group stored in the magazine based on the average condition shown by the sheets throughout the bale. For the bales stored inside the pulp mill, the classification was based on 10 sheets from the middle of the bale since there was evidence that the outer sheets had dried considerably more than would be encountered during normal storage in a conventional pile in a magazine despite the precautions which had been taken to avoid excessive drying.

Table I. Plan Followed in Classifying the Condition of the Sheets of Wet Mechanical Pulp (50% Moisture Content)

No.	*Description of condition*
0	Definitely not usable
1	Doubtful usability for even low-grade paper and board
2	Doubtful usability for even low-grade paper and board
3	Usable for low-grade paper and board
4	Usable for low-grade paper and board
5	Usable for low-grade paper and board
6	Usable for medium-grade paper
7	Usable for medium-grade paper
8	Usable for medium-grade paper
9	Usable for medium-grade paper
10	Usable for medium-grade paper
11	Usable for high-grade paper but price adjustment would be necessary
12	Usable for high-grade paper but price adjustment would be necessary
13	Usable for high-grade paper but price adjustment would be necessary
14	Usable for high-grade paper but price adjustment would be necessary
15	Usable for high-grade paper but price adjustment would be necessary
16	Usable for high-grade paper with complaint on quality but no price adjustment
17	Usable for high-grade paper with complaint on quality but no price adjustment
18	Prime first quality pulp
19	Prime first quality pulp
20	Prime first quality pulp

When the examinations were made on July 13, 1948, of the previously unopened bales stored inside the pulp mill, color photographs were taken of representative sheets after they had been partially dried in the sun. A color photograph also was taken of a representative sheet from the 111 bale stored inside the pulp mill which had been opened previously since there was evidence of an appreciable difference in attack by microorganisms as the result of prior opening of this bale. At the time of the inspection of the pulp in the bales stored in the magazine on Aug. 15, 1948, color photographs also were taken of representative wet sheets from the untreated group and each treated group. Additional color photographs were not taken of sheets from the bales stored in the pulp mill when they were re-examined at that time since there was no evidence of a significant change in condition.

At the time of the inspections of the respective lots of pulp, representative sheets were partially dried by exposing them to the air and sun after which they were shipped to interested laboratories and individuals. Since there was evidence of a limited growth of an organism or organisms producing a light violet stain, particularly along the edges of some sheets of pulp from the 222 and 444 as well as a more general spotted development on the 111 group, representative pieces of 222 and 444 sheets were sealed in envelopes and forwarded to interested laboratories for the isolation and identification of the organism involved.

RESULTS AND DISCUSSION FROM THE STANDPOINT OF PULP MILLS

General Advantages of Closed System–Higher Temperature Operation

A detailed study was not attempted of all of the potential advantages of a closed system–higher temperature operation which can be realized when an effective microorganism control treatment is employed. Under such conditions, the system can be closed so that very little water is lost and operated at higher

temperatures without encountering the increased amount of decay usually obtained in the pulp. In order to conserve a limited supply of toxicant available in Sweden for the work and insure having an adequate amount for the tests, the system was closed and treated during only three 24-hour periods. During these periods, the white water temperature averaged 54°C. (129°F.) in comparison to an average temperature of 38°C. (100°F.) when the system was not closed. A reliable evaluation of all of the different temperature effects for a temperature differential of this magnitude under commercial conditions should be based on a long enough period of time. This would permit maximum adjustment of all of the operations to take full advantage of the potential benefits. However, grinding studies of coniferous woods, such as white spruce and loblolly pine, have shown that higher pit temperatures have the advantage of producing a longer fibered, stronger pulp of a higher freeness, generally with a lower power consumption and a higher grinding rate. In addition, the present study provided indications that the pulp produced while the system was closed and operating at an average temperature of 54°C. (129°F.) had a moisture content between 1 and 2% lower than pulp produced when the system was comparatively open and operating at a temperature of about 38°C. (100°F.). This result was obtained without any particular attempt to adjust operations to take full advantage of the improved conditions provided for moisture removal.

Reduction in water and fiber loss is another advantage to be gained from tightly closing a pulp system so that little or no white water is lost. It is sometimes said that the fibers lost in the white water are the least desirable ones from the standpoint of the manufacture of paper. This is true to some extent and the less desirable fine fibers do comprise the larger proportion of the total fiber loss. However, a significant loss of the longer, more desirable fibers is still being encountered in most pulp mills. Moreover, continued improvement in grinding conditions, such as an increase in grinder pit temperature, and the most effective utilization of new and improved types of grinding stones provide possibilities of increasing the proportion of longer, stronger fibers. Adequate work on all factors in each individual groundwood mill should make it possible to close a groundwood pulp system so that essentially no water is discharged except that retained in the pulp. In addition to the reduction in fiber loss, this would reduce fresh water cost to a minimum and essentially eliminate the question of stream pollution by the mill discharge.

Slime Control

Although the system was not treated continuously during the 1-week period, it was treated with about 25 parts of BSM-11B per million parts of water for at least 6 hours during each day when continuous treatment was not in progress. Based on prior experience in many mills, it was known that this would provide satisfactory slime control. In addition, it would not give a result at the end of the week better than that which would be achieved later during any normal continuous pulp treatment program at a higher concentration of the preservative. Examination of the system on Saturday night, Sept. 27 and Sunday morning Sept. 28, 1947, showed that slime had been well controlled. The channels, chests, and white water tank were essentially free of slime. This was in comparison to the condition at the end of the preceding week which showed that substantial amounts of slime normally accumulated in the system without treatment during a week of operation at an average temperature of about 38°C. (100°F.). It should be recognized that operation of the system at an average temperature of 54°C. (129°F.) for about three 24-hour periods during the week unquestionably would have resulted in a reduced slime growth even though the system had not been treated with the toxicant. However, experience has shown that pulp produced at temperatures above 50°C. (122°F.) and stored untreated is damaged more by microorganisms, particularly decay fungi, than pulp produced at lower temperatures (*4, 5, 6, 11, 12, 13*). It also is adequately demonstrated that a temperature of 54°C. (129°F.) does not exceed the maximum temperature limit which presumably would provide a reversal in this general relationship. In other words, the results for group 111 clearly show that a temperature of 54°C. (129°F.) plus a low level of treatment are both inadequate to provide a desired degree of protection for the pulp.

Retention of the Toxicant by Pulp

Table II gives the results of analyses of a composite sample from all of the bales in treated group 111, a composite sample from all of the bales in treated group 222, and one sheet from each of six bales dispersed throughout treated group 444. These results show the retention for the group of bales given the lowest treatment was 80 parts of BSM-11B per million expressed in terms of the dry weight of the pulp, which is equivalent to 40 p.p.m. or 0.04 kg. per wet metric ton of pulp at 50% moisture content (0.08 pound per 2000-pound ton of wet pulp). The retention for group 222, which is the one of greatest commercial interest, was 0.23 kg. per wet metric ton of pulp (0.46 pound per 2000-pound ton of wet pulp and 0.92 pound per ton of moisture-free pulp). In group 444, the retentions for the different bales show the trend ex-

Table II. Retentions of BSM-11B, a 10% Solution of Phenylmercuric Acetate, as Determined by Analysis of a Composite Sample from All of the Bales in Treated Group No. 111, All of the Bales in Treated Group No. 222 and One Sheet from Each of Six Bales Dispersed Throughout Treated Group No. 444

Identification no.	*Treated or untreated*	*Retention of BSM-11B*		
		Parts per million based on moisture-free-weight of fiber[a]	*Grams per wet metric ton*[b]	*Pounds per wet 2000 lb. ton*[b]
000	Untreated	None	None	None
111	Treated	80	40	0.08
222	Treated	460	230	0.46
444				
Bale No. 1	Treated	5000	2500	5.00
Bale No. 6	Treated	3300	1650	3.30
Bale No. 12	Treated	1800	900	1.80
Bale No. 20	Treated	1600	800	1.60
Bale No. 23	Treated	1800	900	1.80
Bale No. 24	Treated	2000	1000	2.00

[a] Average analyses rounded to nearest 10 p.p.m. for results below 1000 p.p.m. and to nearest 100 p.p.m. for results above 1000 p.p.m.
[b] Calculated from the parts per million in terms of moisture-free weight of fiber on the basis of an average moisture content of 50% for wet mechanical pulp.

pected and all of the retentions were above the range of primary commercial interest. For example, the retention for bale No. 1 was 2.5 kg. per wet metric ton of pulp (5.0 pounds per 2000-pound ton), with a decrease to about 0.9 kg. per wet metric ton (1.8 pounds per 2000-pound ton) for bale No. 12. The retention for the remaining bales included in the group of 24 varied slightly above and below 0.9 kg. per wet metric ton.

Results for Small Samples

Various observations were made by different laboratories on the sets of small samples described in the foregoing. Some of the earlier indications were similar in general trend to the preliminary findings for the bales stored inside the pulp mill. However, the amount of growth of microorganisms obtained on the small samples of the untreated 000 group stored in fruit jars at 30°C. (86°F.) did not approach that encountered in the bales of untreated pulp stored inside the pulp mill, particularly from the standpoint of amount of decay. The differences also were not nearly as distinct between the untreated and treated groups as they were for the bales stored in the magazine under normal commercial storage conditions. This confirms the results of other investigators, particularly Rennerfelt (*35*). Small-scale laboratory storage tests of the type described definitely cannot be employed to obtain reliable information for predicting the results to be expected in full size bales stored under commercial conditions.

Results for Full Size Bales

The bales stored inside the pulp mill represent an accelerated storage test which the results of the final examinations showed was considerably more conducive to the growth of microorganisms than storage in a magazine under normal commercial conditions even though the bales stored inside the pulp mill were not subjected to freezing and thawing. At the time one of the two bales from each group stored inside the pulp mill was inspected on Nov. 3, 1947, after about five weeks of storage, the results were as follows:

"Untreated pulp, marked 000—No spots of decay, no infection along the edge of the pulp sheets. Blueing spots equal about 30% of the area of the sheet.

"Treated pulp, marked 111—No spots of decay, no infection along the edge of the pulp sheets. Blueing spots or indications of blueing equal about 5% of the area of the sheet.

"Treated pulp, marked 222—No spots of decay, no infection along the edge of the pulp sheets. Blueing or iron spots equal about 0.5% of the area of the sheet.

"Treated pulp, marked 444—No spots of decay, no infection along the edge of the pulp sheets. Blueing or iron spots equal about 3 to 10 [spots] per sheet."

The results of the next inspection on Feb. 4, 1948, were influenced by the fact that the bales had been previously opened. It was suspected this would present an unusual condition but it was considered desirable to reserve the remaining bale from each group for the final inspection in preference to opening the bales for an interim inspection. When this suspicion was confirmed at the final inspection, it was decided that the results of the inspection made on Feb. 4, 1948, should be disregarded. This was done with the exception that one photograph was taken on July 13, 1948, to illustrate the difference in condition of the bale from the 111 group which had not

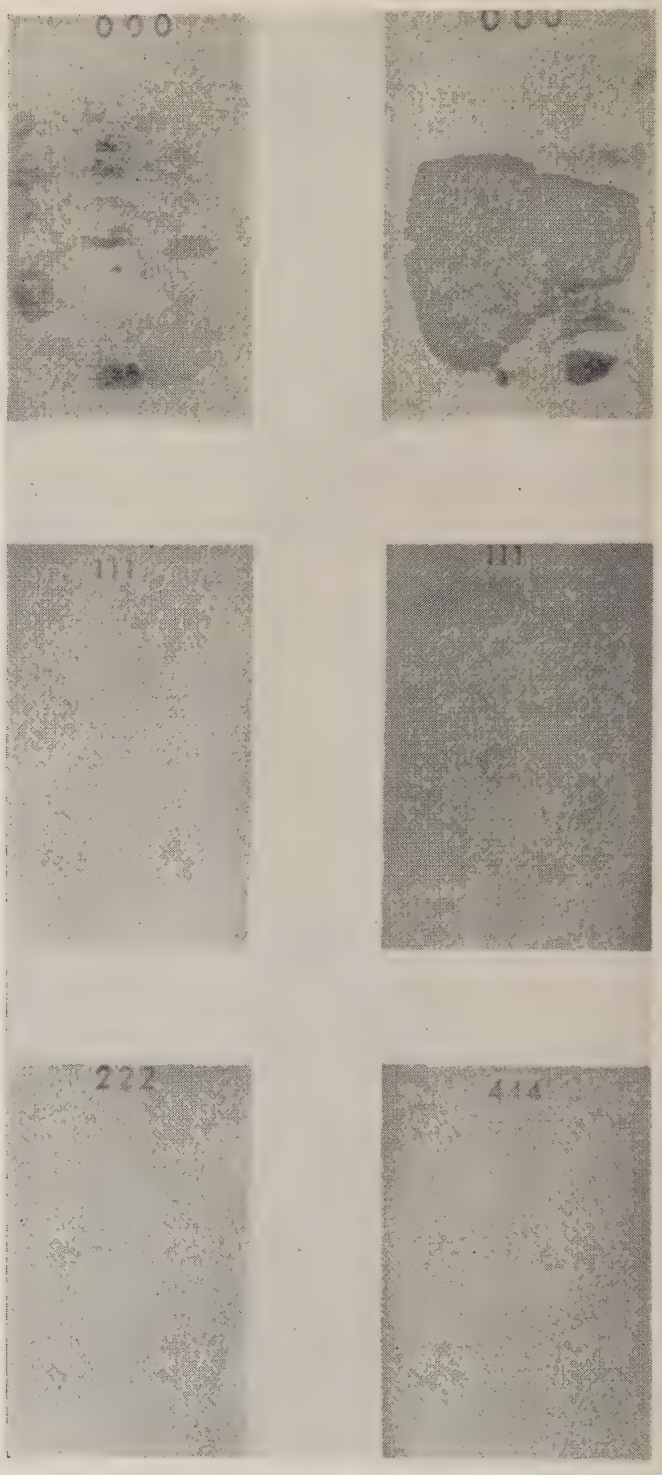


Fig. 1. Appearance of pulp sheets from bale of untreated group and each group treated with BSM-11B, a 10% phenylmercuric acetate solution, after a storage period of about 10 months inside pulp mill

All sheets from bales which had not been opened for prior inspections except 111, middle right. 000, top left, shows least development of microorganisms for untreated pulp with mold and stain predominating. 000, top right, shows typical large area of decay present in untreated sheets with surrounding stain and mold. 111, middle left, treated with 40 grams per wet metric ton in good condition. 111, middle right, received same treatment but is from bale opened for two prior inspections resulting in development of some distinct stain and mold. 222, bottom left, treated with 230 grams and in good condition. 444, bottom right, treated with 1000 grams and in good condition.

been previously opened in comparison to the bale which had.

Table III gives the results of the classification on Aug. 15, 1948, of the condition of 10 sheets from the middle of the one bale from each group stored inside the pulp mill and opened previously only at the inspection on July 13, 1948. The classification was based on 10 sheets from the middle of each bale because excessive drying obviously had retarded development of microorganisms in the outer sheets in each bale. As previously noted, the classifications were based on the plan which has been employed by Bade. A description is given in Table I of the various conditions in terms of the normal attitude of users of pulp up to the present time. Figure 1 shows black and white reproductions of color photographs of representative sheets of pulp from the one bale in each group which were taken on July 13, 1948. The photographs were not repeated on Aug. 15, 1948, since there was no significant evidence of a visible change in condition of the sheets of pulp during this portion of the storage period. This probably was primarily the result of the appreciable drying of even the inner sheets which had already taken place by the time of the inspection on July 13, 1948.

As noted in Table III, the untreated pulp stored inside the pulp mill was given a rating of 7 which represents pulp regarded as usable for medium grade papers but not for high-grade papers. The better sheets from the group of those on which the classification was based are represented by the 000 sheet shown in the top left photograph in Fig. 1 while the poorer sheets are represented by the top right photograph. There was a heavy development of mold and some staining organisms over the surface of the better sheets while the poorer sheets showed mold and stain and had a large decayed area in the central portion which was mandarin (tangerine) orange in color. The sheets from even the lowest treated group were in a much better condition and the one for the bale which had only been open previously at the inspection on July 13, 1948, was given a rating of 17. This rating represents pulp regarded as usable for high-grade paper but with sufficient evidence of microorganism growth so that a complaint would be made by the user. However, no price adjustment would be regarded as necessary. The photograph representing a sheet of this condition is shown in the middle left hand position in Fig. 1. For comparison, a photograph was taken of a representative sheet from the same treated group, 111, which had been opened twice previously, once at the end of about five weeks' storage and again at the end of about four months. This sheet is shown in the middle right position in Fig. 1. There is a general development of mold and stain over most of the sheet and there may have been some incipient decay. The sheet was given a rating of 10 at the final inspection on Aug. 15, 1948. In contrast to these results, the sheets from treated groups 222 and 444 were classed as prime first quality pulp and representative sheets of these groups are shown in the bottom left and bottom right positions, respectively, in Fig. 1.

Table III. Condition of the Different Bales of Wet Mechanical Pulp (50%) Stored in the Pulp Mill and in the Pulp Magazine After a Storage Period of about 11 Months

Identification no.	*Retention of toxicant[a]* *Grams per wet metric ton*	*Pounds per wet 2000-lb. ton*	*No. of bales examined*	*Condition* *Av.*	*Range*
				Pulp stored in mill	
000	...	Untreated	10 sheets in middle of bale	7	...
111	40	0.08	10 sheets in middle of bale	17	...
222	230	0.46	10 sheets in middle of bale	18–19	...
444	1000	2.00	10 sheets in middle of bale	18	...
				Pulp stored in magazine	
000	...	Untreated	10	14.5	2.0
111	40	0.08	10	15.5	1.0
222	230	0.46	10	18.0	1.0
444	800 to 2500	1.60 to 5.00	10	18.0	2.0

[a] A 10% solution of phenylmercuric acetate.

Table III also gives the classifications made on Aug. 15, 1948, of the condition of the pulp in the untreated and treated bales stored in the magazine under commercial storage conditions for about eleven months. Ten bales were examined from the untreated group, 000, and from each treated group, 111, 222, and 444. Table III gives the average rating for the 10 bales from each group and the range of the ratings for the bales; i.e., the difference between the highest and lowest rating for the individual bales in each group. Observations of the areas of sheets previously streaked with a solution of ammonium chloride and potassium dihydrogen phosphate did not show any significant differences in the development of microorganisms on these areas. As shown by the ratings, the untreated pulp stored in the magazine was in a significantly better condition than the untreated pulp which had been inside the pulp mill. The respective ratings were 14.5 and 7, with the 14.5 rating representing pulp regarded as usable for high-grade paper but in such condition that a price adjustment would be necessary. However, the untreated pulp stored in the magazine was heavily infected over the entire area of the sheets with blue staining and mold organisms and there was evidence of some spots which may have been incipient decay. The mottled appearance presented by heavy uniform development of stain and mold organisms is shown by the top left photograph in Fig. 2. By comparison, the sheets from the bales of group 111, which received the lowest treatment, were considerably less heavily infected even though classification under the plan employed resulted in the bales being given a rating of 15.5. The 111 sheets showed a number of small spots of blue staining organisms and a number of larger spots of growth of an organism which stained the pulp a light violet. The extent of the development is illustrated by the top right photograph in Fig. 2.

The sheets in the bales from group 222, the group receiving the treatment being recommended for commercial use, were in good condition. On these sheets and the ones from group 444, the only evidence of microorganism growth was the presence of a light violet stain located almost entirely along the edges of the sheet but with an occasional spot in the inner portion of the sheet which was not connected with a stained area along the edges. The stain was a very light violet

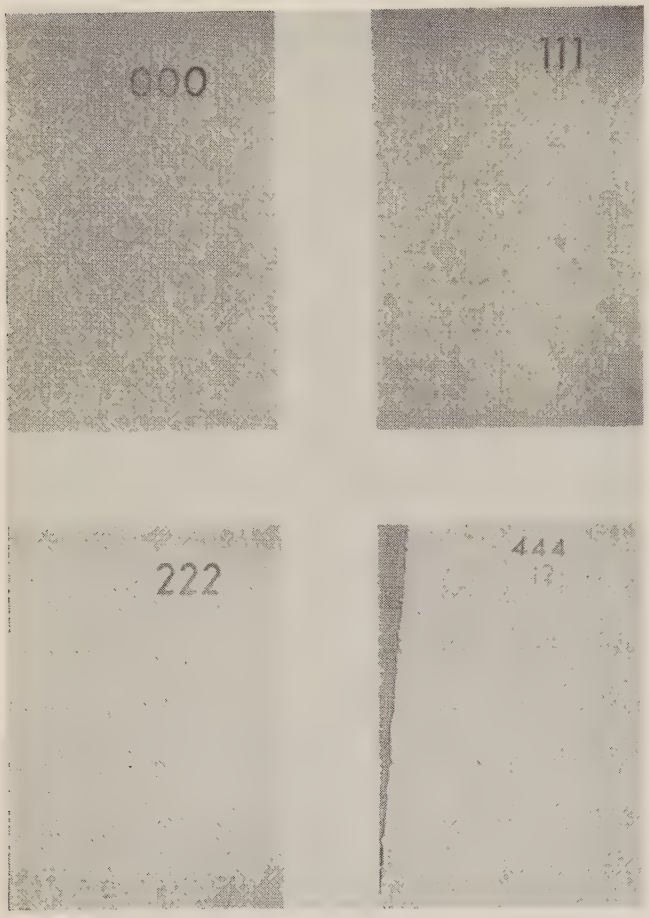


Fig. 2. Appearance of typical pulp sheets from bales of untreated group and each group treated with the toxicant after a storage period of about 11 months in the magazine under commercial conditions

in color and it was difficult to see on sheets after they had partially dried. However, since it occurred to a limited extent even on some sheets from the bales receiving the heaviest treatment, and since there was some possibility of it being confused with incipient decay, it seemed best to conduct some further work on this subject. Pieces of sheets showing the stained areas were forwarded to three laboratories for isolation and study of the organism.

All of the laboratories obtained isolations of the same organism, a species of *Penicillium*. No other organisms were obtained in the isolations. Moreover, microscopic examination of the pulp sheets did not disclose the presence of mycelium of any other organisms. Figure 3 shows a light violet stained area of a pulp sheet from the 444 group with the sparse mycelial growth and the sporophores of *Penicillium* sp. A group of sporophores also is shown at a higher magnification in Fig. 4. Sections of the pulp showed that the growth was essentially confined to the surface of the sheet; i.e., the pulp sheets were not permeated by the mycelium of the mold. Information in the literature (*35*) indicates that the growth of the same or a similar organism probably had been observed a number of times previously and regarded as the growth of rotting fungi. However, the lack of effect of the growth on whiteness and strength of the pulp was demonstrated and included in the following statement by Rennerfelt (*35*):

"In the treated pulp blueing fungi were entirely missing in all concentrations; moulds appeared as superficial discoloration in the lowest. On the other hand rot appeared in part of the samples. In pulp treated with 97 g. pulpasan [6% of ethylmercuric chloride] it covered about 95% of the sheets and gave the pulp a slightly reddish hue. In pulp treated with 240 g. pulpasan the rot appeared as isolated spots here and there on the sheets. The attack in the respective concentrations was of about the same extent as shown in pictures 2 and 3 in Fig. 16. The two highest concentrations were entirely free from rot.

"Probably it is in this case a question of the same rotting fungus as was found in the pulp at the mills B and D. The occurrence, the colour and the appearance and size of the spots showed obvious similarities. A thing common to all three cases was that during continued storage the fungus had spread further in lower concentrations and also began to appear where pulp was being treated with a concentration which was still satisfactory after a shorter storage time. This could also be observed in the pulp at mill F. After 6 months' storage slight violet shadings appeared at the edges of the sheets in bales also treated with 350 [and] 700 g. per ton (Bade 1940). All accordingly this fungus seems to have little influence upon the whiteness as well as on the strength of the pulp. According to analyses carried out at the Papirindustriens Forskningsinstitutt, Oslo, the tearing off length and the burst factor are of the same size with first-rate [and] decayed pulp."

The species of *Penicillium* isolated from the pulp sheets will be made the subject of another paper at a later date. Although the evidence supports the conclusion that it is not an important fungus from the standpoint of deterioration of pulp, the organism is of at least scientific interest because of its high resistance to organomercuric compounds.

For the commercial treatment of wet mechanical pulp (50% moisture content), it is recommended that 200 to 250 grams of BSM-11B per metric ton of wet pulp (0.4 to 0.5 pound per ton of wet pulp) be fed continuously into the white water being returned to the grinders at a point after which no white water is lost before reaching the stones. This recommendation is based on the treatment being conducted in a closed system from which very little, if any, white water is discharged, except that retained by the pulp. Figure

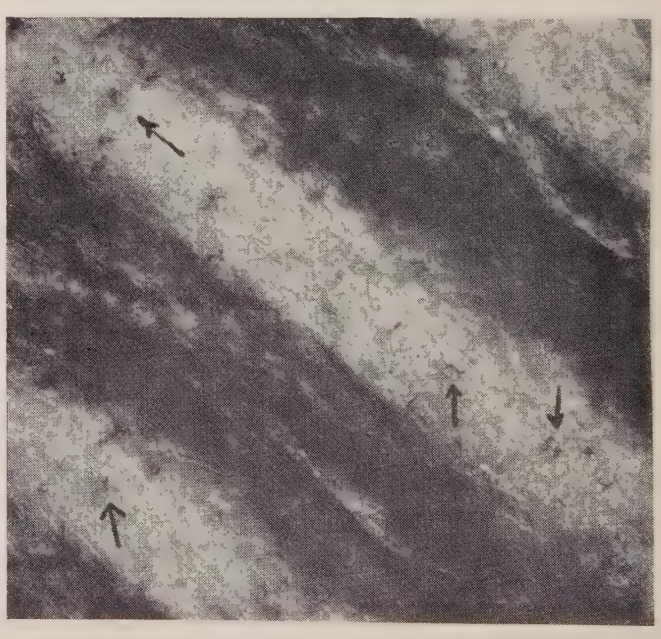


Fig. 3. Light violet stained area of a pulp sheet from the 444 group showing sparse mycelial growth and sporophores of* Penicillium *sp. on the top of the ribs of the sheet. 25×

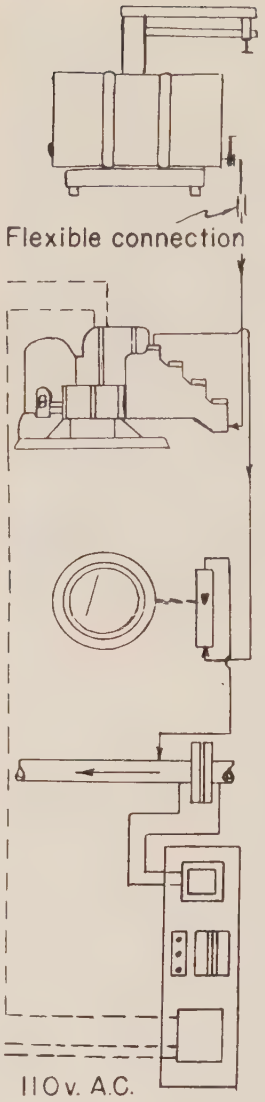
The dark bands are the depressions between the ribs which were not illuminated when the photographs were taken and are not fungus mycelium.

Fig. 4. Pulp from surface of light violet stained area of a sheet from the 444 group showing sporophores of Penicillium *sp. and sparse growth of mycelium. 250×*

5 shows one type of suitable feeding equipment which will accurately feed a liquid toxicant into the system directly from the drums in which it is received. Suitable equipment can be obtained to feed accurately quantities from the smallest of practical interest to any desired maximum. In the type of installation shown, the drum is mounted on a scale and connected to the feeding pump with a flexible connection so that the rate of feeding can be verified as desired from periodic weighings. A suitable feeding pump and an accurate scale of adequate capacity are the only equipment items required. Optional recording and proportioning equipment also are shown in Fig. 5. These can be added to the original basic installation at a later date if a continuous chart record of the feed is desired and if the rate of pulp production is sufficiently variable to justify automatic proportioning equipment in comparison to manual change of the indicating stroke adjustment of the feeding pump.

RESULTS AND DISCUSSION FROM THE STANDPOINT OF PAPER MILLS

The loss of useful fiber in badly decayed pulp, the difficulty of dispersing partially decayed pulp, and odor as well as darkening in color caused by the growth of microorganisms are all losses caused by microorganisms which are quite generally recognized by paper mills. However, the major losses result from the contribution of the infection in the pulp to the growth of slime throughout paper machine systems. Slime consists of microorganisms and accumulations of fibers and debris matted together to give masses and deposits characterized as stringy, pasty, rubbery, tapiocalike, gelatinous, hard, and horny. The organisms involved in pulp and paper mill slime are primarily different species of spore-forming and nonspore forming bacteria, particularly the capsulated forms which thicken their walls by the addition of a gelatinous layer; filamentous fungi of the mold type; and yeastlike organisms. Figure 6 shows a photomicrograph of a commonly occurring capsulated bacterium,



Basic Equipment

Scale:
Beam scale of suitable capacity with $^1/_4$ kg. ($^1/_2$ lb.) accuracy.

Feeding Pump:
Suitable positive displacement feeding pump with adjustable feed having parts in contact with liquid of steel or 18–8 stainless steel.

Optional Additional Equipment

Recording Flowmeter:
Installed in toxicant line to accurately meter and record amount fed into system. Best results are obtained from rotameter type instruments in these small flow ranges.

Proportioning Equipment:
Can be added to control speed of pump motor and hence, the amount of liquid toxicant fed into the system, in direct proportion to the flow in any stock line.

Fig. 5. Suitable equipment for controlled feeding of undiluted liquid toxicant from a drum into mill systems

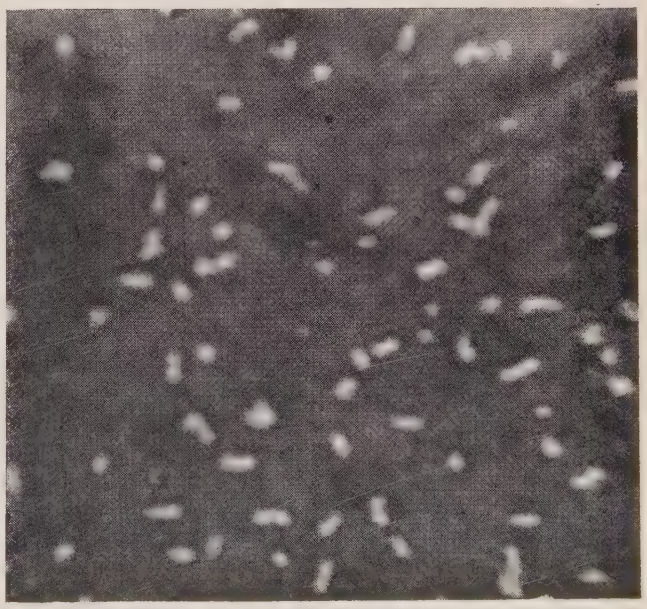


Fig. 6. Cells of Aerobacter aerogenes *surrounded by gelatinous-like capsules. 950×*

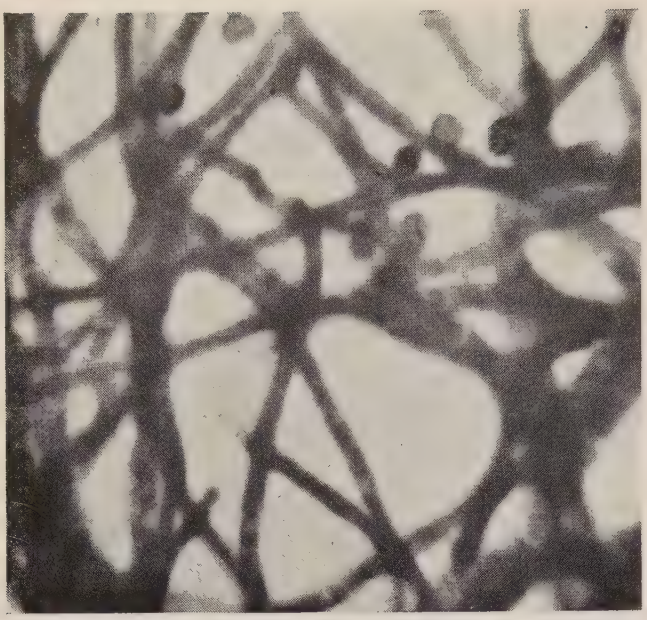


Fig. 7. Interlaced mycelium and conidia of Aspergillus niger. *950×*

Fig. 8. Slime composed of bacteria, fungus hyphae, fibers, and general debris. 950×

Aerobacter aerogenes, while Fig. 7 shows a photomicrograph of a commonly occurring mold, *Aspergillus niger*. It is apparent that the small capsulated bacterial cells could be present in paper machine systems in substantial numbers without causing appreciable difficulties if they did not adhere to one another and accumulate on the surfaces of pipes, screens, headboxes, wire trays, white water tanks, etc. Moreover, it is apparent from Fig. 7 that the mycelium of the molds and also the similar mycelium of blue staining fungi have the physical qualifications necessary to act as a reinforcing material for a slime mass. If the slime accretions can be likened to concrete, the mycelium of the fungi can well be regarded as "reinforcing wire" while the bacteria fill the role of "cement" with particles of fine fibers, filler, rust, etc., functioning as the "aggregate." Tough, stringy, troublesome slime normally has a composition of this type and Fig. 8 illustrates a slime sample composed of bacteria, fungus mycelium, fibers, and general debris.

A form and a chart for use in assembling data have been developed and are being used by paper mills in the evaluation of the losses caused by slime of which the following are the more important (*9*):

1. Lost production time (referred to as down time in some mills):
   - A. Wash-ups and squirt-ups not required by order changes.
   - B. Wire cleaning, removal of spots, etc.
   - C. Felt washing.
   - D. Felt repairs and felt changes to the degree that deterioration by microorganisms requires the repair and change of felts during normal production time.
   - E. Breaks, removal of paper from driers, and removal of paper from calender stacks, for those breaks caused by slime.
   - F. Miscellaneous items resulting from slime, such as cleaning slime from machine screens, removing and cleaning suction boxes, trouble with sticky stock, cleaning presses and press doctor, difficulty getting paper off wire, etc.
2. Decreased equipment performance:
   - A. Decreased speed of operation of machines resulting from frequent breaks and/or loss of efficiency of wires and cylinder molds blinded by slime and felts plugged with slime and slime-bound fine fiber and filler particles.
   - B. Increased steam required to dry paper received from wires and felts operated at decreased efficiencies.
3. Loss of heat, chemicals, filler, fiber, and water:
   - A. Loss of heat, chemicals, filler, and fiber in white water discharged to sewer.
   - B. Increased use of fresh water to replace white water discharged to sewer to reduce the difficulties caused by slime.
4. Decreased life of clothing and equipment:
   - A. Decreased wet felt life resulting from deterioration by microorganisms.
   - B. Decreased wire, cylinder mold, and other equipment life resulting from the excessive use of corrosive toxicants, such as chlorine and copper sulphate.
   - C. Corrosion of metal equipment resulting from the production of hydrogen sulphide by sulphate-reducing microorganisms particularly under the stimulation of carbon dioxide from decomposing organic matter.
5. Loss of finished product:
   - A. Loss of profit, cost of segregating, and cost of repulping paper culled because of slime spots, slime holes, etc., and reutilized at the original grade.
   - B. Additional loss in grade or complete loss of that portion of the total culled paper which cannot be reprocessed at the original grade.
   - C. Loss involved in the settlement of customer claims resulting from defects caused by slime in the finished product.

D. Loss in weight resulting from over-drying paper to obtain uniformity of moisture content and compliance with customer specifications.

When slime accretes to a degree that a wash-up is necessary or desirable at less than seven-day intervals for reasons other than a color or a grade change, the total loss caused by slime usually exceeds $1.00 per ton of production. For paper mills in general, the total loss caused by slime varies considerably from mill to mill, different machine systems in the same mill, different furnishes in the same machine system, and different times of the year. The total loss resulting from the individual components noted in the foregoing usually will be between $1.00 and $5.00 per ton of paper when slime is not controlled. The slime measuring unit developed by Dean (*10*) has been found helpful in estimating the rate of slime accretion in paper machine systems. Briefly, the unit is based on the principle of determining the amount of accretion of slime in a given period of time on a certain area of a wooden panel mounted in a stainless steel housing designed so that a relatively constant flow of furnish of headbox consistency flows over the surface of the panel. Although furnish of headbox consistency is preferred when the unit is employed for determinations in paper machine systems, white water may be used. The unit is employed in combination with the form and control chart mentioned in the foregoing to obtain an over-all evaluation of the results from a slime control treatment program. The soundest plan is to base the program on the principle of treating to the point of diminishing returns; i.e., the treatment should be conducted so that the maximum saving is obtained above the cost of the slime control program including the cost of the toxicants, amortization and maintenance of any feeding equipment employed, and supervision.

When the duration of storage of mechanical pulp slush stock before use is limited to several hours in a chest or even a day, the degree of infection which develops usually does not create a serious problem. In general, the most efficient use of toxicants under such conditions is obtained by concentrating all of the slime control treatment in the paper machine systems, and chlorinating the fresh water supply if it carries a substantial amount of infection. However, experience with major slime problems arising from the use of groundwood slush stocks which has been stored in tanks or chests for several days to two weeks shows that the infection in the pulp must be kept at a reasonable level. The same applies to an even greater degree to wet lap and sheet pulp particularly because of the longer storage period which may vary in general from a few weeks to one year or more. Adequate treatment of the pulp to protect it during the storage period is a sound policy from the standpoint of slime control in paper mills as well as preservation of original pulp quality until the time that it is used in the manufacture of paper. There have been numerous experiences in which wet lap or sheet pulp containing a heavy infection of bacteria and fungi has been the cause of major losses from slime. In addition to keeping the amount of infection in the pulp at a practical minimum, a portion of the toxicant added to the pulp will be retained in an effective condition and transferred to the paper machine system with the pulp where it will help in controlling slime. In this respect, Pehrson and Lindberg (*28*) have found that the addition of aluminum sulphate to a pulp suspension containing phenylmercuric acetate increased the effectiveness of the phenylmercuric acetate as determined with a bioassay method. This was attributed to a reduction in the amount of the organomercurial adsorbed by the pulp and thereby rendered ineffective against microorganisms. Evidence was presented to show that the observed result was not caused by the effect on the toxicity of phenylmercuric acetate in the absence of pulp. It was not established whether the reduced adsorption was the result of a change in pH produced by the addition of the aluminum sulphate or some other action of the aluminum sulphate. However, the evidence does show that the addition of alum within the range of amount employed in many furnishes would increase the effectiveness of phenylmercuric acetate. It seems probable that the action would be effective in freeing a portion of the phenylmercuric acetate adsorbed on groundwood after even a long storage period, although this has not been demonstrated. In any event, some portion of the organomercurial used as a preservative for the pulp will be effective in controlling slime and the amount may be increased in the environment provided in paper machine systems. A large amount of practical experience on control of the mixed microflora encountered in paper mill systems has shown that outstanding slime control usually cannot be maintained over an extended period of time by the use of organomercurials alone at concentrations which it is feasible to employ in paper machine systems. It should be recognized that these concentrations are substantially lower than those which it is practical to maintain in a mechanical pulp system closed so that very little, if any, white water is discharged except that retained by the pulp. However, despite the limitations, a portion of the phenylmercuric acetate transferred to paper furnish in treated wet mechanical pulp will be of some help in controlling slime in the paper machine systems in which the pulp is used.

BSM-11B, a 10% solution of phenylmercuric acetate, does not transmit any odor to pulp. Pulp treated with it can be used for the manufacture of various types of paper in which even very slight traces of foreign odors would be objectionable. The use of phenylmercuric compounds also does not present problems different from those involved in the handling of many other chemicals in common use. Workers handling the toxicant should observe the quite standard precaution of wearing rubber gloves and goggles. If they accidentally get it on their skin it should be removed by washing promptly and thoroughly with cool water and soap.

Phenylmercuric compounds are employed in a number of different preparations used in the treatment of humans, such as the preservation of blood plasma, ointments for skin infections, ointments for the treatment of burns, and as a preservative in certain types of nose drops. Intravenous injections of these compounds also have been successfully employed in the treat-

ment of humans with infections of the blood stream (*25*). In addition, it has been demonstrated that most foods other than fresh vegetables and eggs contain mercury with the result that all persons are continually ingesting a small amount of mercury with their food, and also continually excreting it in their urine and feces (*18*). Table IV gives the results of two tests in which 10 rabbits each were given single oral doses of 140 and 220 mg. of BSM-11B per kg. of body weight (*15*). As shown by the data given in this table, all of the rabbits given a dosage of 140 mg. per kg. of body weight remained healthy and continued to gain weight. From the group which were given a dose of 220 mg. per kg. of body weight only 3 of the 10 died showing that the minimum lethal dosage (LD_{50}) is above 220 mg. of BSM-11B per kg. of body weight. For comparison, Table V presents the information reported by Kehoe, Deichmann-Gruebler, and Kitzmiller (*20*) on sodium pentachlorophenate. These results show that BSM-11B has a comparable or lower toxicity to rabbits than sodium pentachlorophenate which has been extensively used throughout the industry in paper mills manufacturing paper for use in food containers.

SUMMARY

Information is presented in support of the conclusion that the growth of microorganisms in wet mechanical pulp (50% moisture content) can be satisfactorily controlled for a storage period of one year or more by treatment with 0.23 kg. of BSM-11B, a 10% solution of phenylmercuric acetate, per wet metric ton of pulp (0.46 pound per 2000-pound ton). The treatment was added to the white water with the system closed so that very little white water was discharged. Slime control was achieved throughout the pulp system by the combined effect of the treatment and operation at a temperature of 54°C. (129°F.). The other advantages of pulp mill operation at higher temperatures thus were realized without a sacrifice in pulp quality. The importance of microorganism control in mechanical pulp is stressed particularly from the standpoint of the relationship to the losses caused by slime in paper mills using the pulp. The general classes of losses and the more important individual components are reviewed and information briefly presented on methods for their evaluation including a unit for measuring the rate of slime accretion in paper machine systems.

Table IV. Effects of Oral Administration to Rabbits of Single Doses of BSM-11B (*15*)

Rabbit no.	*Initial body weight, kg.*	*Dose of BSM-11B, mg.*	*Body weight after two weeks, kg.*	*Fate*
Dosage level of 140 mg. per kg. of body weight[a]				
1	2.29	321	3.00	Survived
2	3.02	423	3.21	Survived
3	2.32	325	2.52	Survived
4	1.73	242	1.90	Survived
5	1.75	245	1.76	Survived
6	3.42	478	3.61	Survived
7	3.48	487	3.62	Survived
8	2.95	413	3.11	Survived
9	2.51	352	2.68	Survived
10	2.18	291	2.32	Survived
Dosage level of 220 mg. per kg. of body weight[b]				
1	1.81	398	1.87	Survived
2	2.50	550	2.46	Survived
3	2.62	576	...	Died in 8 days
4	2.93	645	2.71	Survived
5	2.94	647	2.71	Survived
6	1.78	392	1.79	Survived
7	2.52	554	2.21	Survived
8	2.30	506	2.32	Survived
9	2.62	576	...	Died in 9 days
10	2.10	462	...	Died in 6 days

[a] Administered by stomach tube in the form of a mixture with cottonseed oil which formed a sufficiently stable emulsion to permit accurate dosage. The animals were observed for a period of two weeks, at the end of which all appeared normal and healthy.

[b] Administered by stomach tube in the form of an aqueous solution. The surviving animals were observed for a period of two weeks, at the end of which the seven survivors appeared normal and healthy. The minimum lethal dosage (LD_{50}) therefore is greater than 220 mg. per kg. of body weight.

APPENDIX

METHOD FOR THE DETERMINATION OF MERCURY IN WOOD PULP

The following procedure is based on the tentative method for mercury in leafy vegetables described in "Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists" (Association of Official Agricultural Chemists, Washington, D. C., 6th edition, 1945, p. 470), and on the colorimetric dithizone method of Fischer and Leopoldi (*Ztschr. f. Analyt. Chem.*, No. 103, 241 (1935). It is recommended for the determination of small amounts of mercury in pulp and paper. In its present form it is intended to be used on materials containing from 1 to 1000 parts of mercury (Hg) per million. An operator can run three or more complete analyses per day. No special skill is required, but more care must be exercised than in ordinary macroanalytical methods.

Apparatus

Two-liter round bottom flasks fitted with Liebig condensers with ground glass connections are recommended for digestions. Any equivalent equipment, such as the flask equipped with an internal condenser described in the A.O.A.C. method may be used.

Two 500-ml. separatory funnels.
Three 125-ml. separatory funnels.
Two 50-ml. glass-stoppered volumetric flasks.
Two 50-ml. graduated cylinders.
One thermometer, 0 to 100°C.
Two 10-ml. graduated cylinders.
Several small beakers, weighing bottles, and watch glasses.
A spectrophotometer with several 10-ml. cuvettes.
One glass-stoppered Erlenmeyer flask, 125 ml.
One 500-ml. Erlenmeyer flask, with an air condenser.
Two short-stemmed funnels.
Qualitative grade filter paper.
Absorbent cotton.
An all-glass distillation apparatus may be necessary.

It is advisable to test all apparatus with a little dithizone solution before it is used, for apparently clean glassware may contain contaminants to destroy considerable quantities of dithizone. The stopcock grease used in the separatory funnels must not discolor dithizone solution; lubricant dispensed from a metal tube has been found unsuitable.

Reagents

Hydrogen peroxide (H_2O_2)—30% solution, chemically pure grade.

Standard mercury (Hg) *solution*—Weigh accurately about 500 mg. of pure mercury, and dissolve it in

Table V. Effects of Oral Administration to Rabbits of Single Doses of Sodium Pentachlorophenate in Aqueous Solution (*20*)

Rabbit no.	*Initial weight, g.*	*Dosage expressed as pentachlorophenol in 1% NaCl*	*Dosage in mg. per kg. of body weight*	*Fate*	*Remarks*
P 22	2086	10.0 ml. of 1%	48	Survived	Slight loss of weight
P 27	2170	10.0 ml. of 2%	92	Survived	Ill for short time
P 28	2329	20.0 ml. of 2%	172	Survived	Slight loss of weight; temperature 105.8°F.
P 32	2686	25.0 ml. of 2%	186	Survived	Rapid respiration several days
P 33	2753	30.0 ml. of 2%	218	Died in 3¾ hours	Temperature 110.0°F.
P 29	2340	30.0 ml. of 2%	256	Died in 6 hours	Temperature 109.0°F.

nitric acid. Dilute to 1 liter. Dilute 10 ml. of this stock solution to 500 ml. with redistilled water to make a solution containing about 10 micrograms of mercury per ml.

Nitric acid (HNO_3)—If 50 ml. of acid shows a blank of more than 4 micrograms of mercury purify the acid by distilling-over sulphuric acid in an all-glass apparatus and adjust to about 70% HNO_3. Two dilute nitric acid solutions are prepared from this: 1 plus 1, and 1 plus 19, in redistilled water.

Diphenylthiocarbazone (C_6H_5—NH—NH—CS—N:N—C_6H_5) ("Dithizone")—The dithizone ordinarily sold by chemical supply houses is purified as follows: Dissolve about 20 mg. of commercial dithizone in 100 ml. of pure carbon tetrachloride, and filter into a 500-ml. separatory funnel. Extract with 1:1000 aqueous ammonia (see next paragraph) until the green color has almost entirely left the carbon tetrachloride layer. Combine the orange-yellow ammonia solutions, and wash once with CCl_4. (This should turn the CCl_4 green; if it does not, and if the liquids do not separate cleanly, contamination is usually indicated. In such cases it is better to begin again than to continue with the contaminated material.) Acidify the aqueous layer with dilute sulphuric acid and extract it with 100 ml. of fresh pure carbon tetrachloride. Wash the resulting deep green solution of dithizone in carbon tetrachloride several times with redistilled water, and store it in a brown-glass, glass-stoppered bottle under very dilute sulphuric acid, in a refrigerator. Dilute portions of this concentrated stock solution with 3 volumes of pure carbon tetrachloride to obtain the extraction solution. The latter is stored in a brown-glass, glass-stoppered bottle, and is kept in a refrigerator when not in use.

Water—The distilled water, when made slightly ammonical, should give practically no or only a weak rose coloration when shaken with dithizone in carbon tetrachloride. It should not give a distinct red color. If it does, it must be redistilled through an all-glass apparatus. Water so purified is called redistilled water in this procedure.

Dilute aqueous ammonia—Dilute 1 ml. of concentrated (28%) aqueous ammonia to 1 liter with water which has been tested as described above.

Hydroxylamine sulphate (orhydroxylamine hydrochloride) $(NH_2OH)_2.H_2SO_4$ or $NH_2OH.HCl$)—The crystalline compound and its 10% solution in water are both required. The sulphate and hydrochloride are interchangeable in this procedure, and either may be used.

Potassium iodide (KI)—One per cent aqueous solution and chemically pure crystals are both required.

Sodium arsenite ($NaAsO_2$)—Five per cent solution of reagent grade $NaAsO_2$ in pure water.

Sodium thiosulphate ($Na_2S_2O_3.5H_2O$)—One per cent solution of the chemically pure crystals in water.

Potassium permanganate ($KMnO_4$)—Reagent grade crystals, and a saturated aqueous solution.

Sodium sulphite (Na_2SO_3)—A 1% solution of sodium sulphite in water may be used in place of the dilute sulphurous acid recommended by Fischer and Leopoldi.

Carbon tetrachloride (CCl_4)—Use Reagent Grade CCl_4 as received. Recover used solvent by washing with dilute aqueous KI acidified with H_2SO_4, then with dilute aqueous sodium hydroxide, finally several times with distilled water. Distill through an all-glass system.

Sulphuric acid (H_2SO_4)—One volume of pure concentrated sulphuric acid plus four volumes of distilled water.

Procedure

The sample must first be digested until it is entirely soluble in water. This is accomplished by heating it under reflux with HNO_3 and $KMnO_4$. Place a weighed sample of pulp or paper estimated to contain about 5 to 200 micrograms* of mercury in a 2-liter round-bottom flask having a Liebig condenser attached to it with a ground-glass joint. Add a solution of 50 ml. of concentrated HNO_3 in 200 ml. of distilled water.

Reflux the mixture for about one-half hour, or until the pulp is well disintegrated. Cool the flask, remove the condenser, and add 14 grams of $KMnO_4$ cautiously; if the solution is hot the reaction may be quite vigorous. Flush the neck of the flask with distilled water to wash down any permanganate crystals, replace the condenser, and reflux the mixture gently for 15 minutes. Cool the flask somewhat, and add another 10 grams of $KMnO_4$; there is little danger of vigorous reaction at this stage. Replace condenser and reflux the mixture for 12 minutes. Cool it again, and if necessary add 10 grams of $KMnO_4$ and 20 ml. of HNO_3, and continue the digestion for 15 minutes. Cooling, addition of $KMnO_4$ and HNO_3, and subsequent heating are continued until the purple color of the $KMnO_4$ persists when the liquid is heated almost to boiling. For each 4 grams of $KMnO_4$ used, 5 ml. of HNO_3 (70%) is required to combine with the K and reduced Mn. A little experience will tell how much $KMnO_4$ is required for a sample of a given size; e.g., for 1 or 2 grams of pulp the use of 24 grams of $KMnO_4$ has been found ample.

When the flask has cooled somewhat, add 30% H_2O_2 slowly and cautiously through the condenser. There is considerable evolution of gas, which is sometimes delayed for a short time, and there is danger of

* A microgram is one millionth of a gram (0.000001 gram).

losing part of the contents of the flask if H_2O_2 is added too rapidly to a warm solution. After the manganese oxide has been dissolved, boil the mixture under reflux until the excess H_2O_2 has been destroyed. Flush the condenser with distilled water several times during this step. At this point the digestion mixture should be a clear solution, with a slight rose color due to manganese salts.

Place the cooled solution, or an aliquot containing about 100 micrograms of Hg, in a separatory funnel, and add 0.5 gram of crystalline $NH_2OH \cdot HCl$. To the resulting solution add about 5 ml. of the diluted dithizone solution, and shake the mixture for about 15 seconds. The CCl_4 layer will then be green, orange-yellow, violet, or some intermediate color, depending upon the amounts of mercury and other metals present. Allow the CCl_4 layer to separate, draw it off, and place it in a smaller separatory funnel. Extract the aqueous layer repeatedly with 5 ml. portions of fresh dithizone solution until the CCl_4 layer no longer turns orange-yellow. Longer shaking is required as the concentration of Hg in the aqueous layer is reduced. When a green or violet or dirty-green CCl_4 layer is obtained, extract the aqueous layer once more with a few milliliters of dithizone solution plus about 5 or 10 ml. of CCl_4. Combine all the CCl_4 solutions in the second separatory funnel. Discard the aqueous layer since all of the Hg is now in the CCl_4 layer.

Shake the combined CCl_4 solutions with 50 ml. of distilled water, allow the layers to separate, and draw off the CCl_4 into a clean separatory funnel. Wash the aqueous layer once with a little CCl_4, and add the CCl_4 washings to the first CCl_4 layer.

To the combined washed CCl_4 solutions add 60 ml. of distilled water, 0.5 ml. of 5% $NaAsO_2$, 10 drops of 1:4 H_2SO_4, and a few small crystals of KI. Shake thoroughly for 20 seconds, allow the layers to separate, and draw off the green dithizone layer carefully. Wash the aqueous layer, which now contains all of the Hg, once with a little CCl_4. Discard the CCl_4 solutions.

Add 2 ml. of concentrated ammonia (28%) to the aqueous layer, and extract it with 5-ml. portions of dithizone in CCl_4. The first extracts are usually orange-yellow; when the CCl_4 is no longer orange-yellow the extraction is complete, and the mercury is again in the CCl_4 solution. The last CCl_4 extract is ideally colorless, but in practice is a pale yellow, which can readily be distinguished from the orange-yellow color. Wash the aqueous layer once more with CCl_4, then discard the water layer. There should be no insoluble brown or yellow material at the liquid-liquid interface during the extraction from ammoniacal solution. This will appear, however, if the manganese-containing digestion solution was not completely removed from the original dithizone extract. The appearance of such material leads to low results.

Wash the combined dithizone extracts with 40 ml. of redistilled water. Wash the water once with CCl_4 and add the CCl_4 washing to the original solution in another separatory funnel.

To the combined orange-yellow CCl_4 solutions add 40 ml. of redistilled water, 5 ml. of 1% sodium thiosulphate, and 1 ml. of 1:19 nitric acid. Shake the mixture for 30 seconds. The mercury is transferred to the aqueous layer. Draw off and discard the green CCl_4 layer, and wash the aqueous layer with CCl_4. Draw this CCl_4 off carefully. Filter the water layer through a small plug of wet absorbent cotton in a short-stemmed funnel to remove CCl_4 droplets, into a 500-ml. Erlenmeyer flask. Wash the separatory funnel with two 5-ml. portions of redistilled water, and pour these washings through the cotton plug also.

Add 6 ml. of saturated aqueous $KMnO_4$ and 1 ml. of 1:1 HNO_3 and fit the flask with an air condenser with either a ground-glass connection, or a rubber stopper which has been previously boiled in water. Heat the flask on a steam bath for 8 or 10 minutes. Wash the condenser and flask down with a little redistilled water, and cool the solution to 33 to 40°C. Add $NH_2OH \cdot HCl$ (10% in water) drop by drop with swirling, until the precipitated manganese oxides just redissolve, then add 7 or 8 drops excess reagent. Insert a clean thermometer and reheat the flask to 60°C. Remove the thermometer, set the flask aside with a watch glass over the mouth for a minute, and finally cool to 22 to 26°C.

Place the solution in a separatory funnel and extract with 5-ml. portions of the diluted dithizone in CCl_4 as before, drawing off each extract separately, and combining the extracts in a glass-stoppered flask. When the CCl_4 solution remains green or greenish all the mercury has been transferred to the CCl_4 layer. Keep a record of the volume of dithizone solution used. Wash the water layer once more with a few milliliters of dithizone solution diluted with about 2 volumes of fresh CCl_4. Combine the CCl_4 solutions, filter through a dry filter paper into a clean dry 50-ml. volumetric flask, wash the paper with CCl_4, and dilute the filtrate to 50 ml. with CCl_4. If the amount of mercury was too small to convert the first 5 ml. of dithizone to orange-yellow, dilute to 10 or 25 ml. rather than 50. Allowance must be made for such changes in making final calculations.

Transfer this accurately diluted solution to a separatory funnel and wash once with redistilled water, then with 5-ml. portions of 1:1000 aqueous ammonia until the water layer is no longer yellow. This removes the excess dithizone and leaves the Hg in the CCl_4 solution as orange-yellow mercury dithizonate. Wash the CCl_4 solution once with redistilled water containing a few drops of 1:4 H_2SO_4. The transmission of light of this orange-yellow solution at 485 mmu may be used as a measure of the Hg content of the solution, but it is better to proceed as follows:

Shake the orange-yellow mercury dithizonate in CCl_4 twice with about 5 ml. of 1% KI containing 5 to 10 drops of 1:4 H_2SO_4. This transfers the Hg to the aqueous layer and liberates dithizone in the CCl_4. Separate the green CCl_4 layer and wash it with about 10 to 20 ml. of redistilled water, then with water containing a little sulphurous acid (H_2SO_3) or Na_2SO_3 plus excess H_2SO_4. After the layers have separated, filter about 10 ml. of the CCl_4 solution through a dry filter paper into a cuvette and measure the color. If this solution has too high light absorption, dilute it accurately using a pipet and volumetric flask, with CCl_4, to obtain a less intensely colored solution suitable for the measurement of light transmission. Use the absorption of light at 620 mmu to estimate the

concentration of dithizone, and thus of Hg in the solution from which this was derived.

For calibration of the light transmission readings take a known amount of standard Hg solution through the same procedure. Repeat the standardization with various amounts of Hg until the relationship is firmly established.

A blank must be run on the reagents. Use the same amount of $KMnO_4$ and HNO_3 as was required to oxidize the pulp in the blank run. It is well to have a good supply of all reagents on hand so that it is not necessary to run blanks frequently as individual lots of reagents are consumed. A daily blank on the dithizone solution is also required since variable residual color is left after extraction of such solutions with ammonia. The method of using this blank is described in the discussion below. The blank is prepared as follows:

Dilute 10 ml. of extraction dithizone to 50 ml. with CCl_4. Wash once with redistilled water, then with 5-ml. portions of 1:1000 ammonia until the aqueous solution is no longer yellow. Wash twice with 1% KI acidified with dilute H_2SO_4, once with redistilled water, and finally with redistilled water containing a few drops of 1% Na_2SO_3 and several drops of dilute H_2SO_4. Filter 10 ml. of this CCl_4 into a cuvette and observe the transmission of light at 620 mmu, relative to pure CCl_4. The blank for 10 ml. dithizone generally corresponds to 2 or 3 micrograms of mercury.

Discussion

1. Dithizone in carbon tetrachloride is reasonably stable when kept in a refrigerator under dilute sulphuric acid. The diluted solution used for extractions cannot practically be so stored during the day, however, and it deteriorates slightly in the course of a few days. Thus, a sample after several days at room temperature no longer becomes nearly colorless when exhaustively extracted with dilute ammonia (1:1000). The residual color is yellowish, and can easily be mistaken for the yellow of mercury dithizonate. However, its absorption maximum is about 420 mmu rather than 485 mmu. If this yellow solution is treated in the usual manner with KI and H_2SO_4 it becomes green; washing with water lightens the green color considerably, but does not remove it. The final solution, after washing with H_2SO_3 resembles to some extent the green of dithizone, but has absorption maxima at about 425 and 620 mmu, and a minimum at 550 mmu; dithizone in CCl_4 has maxima at 455 and 620 mmu, and a minimum at 520 mmu.

The yellow or green dithizone blank may be used as a reference solution in the spectrophotometer. However, since both yellow and green blanks change color, especially in strong light, it is not practical to keep such solutions for comparison even for a day. Rather, pure CCl_4 may be used for the actual transmission standard, and the readings corrected. Correction may be done in either of two ways: (1) the number of micrograms of Hg corresponding to the transmission observed for the dithizone blank is obtained from the calibration curve, and subtracted from the number of micrograms obtained from the original reading on the dithizone from the mercury solution, the net being the micrograms of mercury in the sample; (2) the transmission reading for the mercury solution is divided by the transmission reading for the dithizone blank, and this corrected transmission is used to obtain the micrograms of mercury from the calibration curve. Thus if the determination required 10 ml. of dithizone for extraction, the final solution had 27.0% transmission, and the blank for 10 ml. of dithizone had 96.5% transmission, the corrected transmission for the determination would be 27.0/0.965 or 28.0%, corresponding to 65 micrograms of mercury in the original sample.

2. It is advisable to check the method and reagents frequently by means of standard mercury solutions. In one case an old 10% hydroxylamine sulphate solution, although performing its functions of decomposing and dissolving excess permanganate satisfactorily, invariably yielded solutions from which only about one-fifth of the mercury added could be extracted by dithizone. When this solution was replaced by freshly prepared 10% hydroxylamine hydrochloride (which is interchangeable with the sulphate in this procedure), the recovery of mercury was again complete.

3. A study of the reported values of Fischer and Leopoldi (loc. cit.) shows that they obtained, on the average, about 6% error with the colorimetric method, using a Hellige-Autenreith colorimeter, and about 3% error with the titrimetric method. We have found that with the Coleman spectrophotometer we averaged about 4% error in the same range of quantities of mercury (10 to 120 micrograms).

The titrimetric and mixed-color methods described by Fischer and Leopoldi appear to be better adapted to quantities below 10 micrograms of mercury than the colorimetric method described here. However, with proper care, and by diminution of solvent volume, the colorimetric method (using a spectrophotometer) should be reasonably accurate down to 1 microgram of mercury.

4. A calibration chart for conversion of spectrophotometer readings to micrograms of mercury can be prepared.

5. The analyst should note, as he proceeds with the analysis, how much dithizone solution is required at each step. If at any stage there is a marked diminution in the volume required to extract the mercury, the analysis should be given little weight. Even with the precautions incorporated in the foregoing method serious losses of mercury are occasionally noted. Since most errors result from contamination, it is imperative to remove all traces of previous solutions from the separatory funnels, etc., at each step.

Experimental Results

Two types of checks on the accuracy of the method were run. In one group, a known amount of phenylmercuric acetate was added to a 10-gram sample of wood pulp (supposedly free of mercury), and the mixture of pulp and preservative was digested with HNO_3 and $KMnO_4$ in the usual way, then extracted with dithizone, etc. As a blank, the procedure was carried out using 10 grams of the same wood pulp, the same amount of $KMnO_4$ and HNO_3, but no phenylmercuric acetate or other mercury was added. This group consists of analyses 1 through 5 in Table VI. The "blank" is the average "Hg" found in the first three analyses. It is made up of the dithizone blank and reagent blank,

Table VI. Results of Analyses of Standard Mercury Solutions

No.	Added	Micrograms of mercury (Hg) Total found	Blank	Net found	Error
1	0	17.3	18.3	−1.0	−1.0
2	0	16.7	18.3	−1.6	−1.6
3	0	21.0	18.3	+2.7	+2.7
4	47.3 (put in as BSM-11B)	67.5	18.3	49.2	+1.9
5	47.3	66.2	18.3	47.9	+0.6
6	107.1 (put in as $Hg(NO_3)_2$)	109.6	3.6	106.0	−1.1
7	71.4	76.5	3.6	72.9	+1.5
8	35.7	35.5	2.4	33.1	−2.6
9	110.7	117.1	2.0	115.1	+4.4
10	107.1	112.5	2.0	110.5	+3.4
11	89.2	93.5	3.6	89.9	+0.7
12	89.2	97.7	6.6	91.1	+1.9

plus any mercury that might have been in the pulp used.

The second group was obtained by adding known amounts of the standard mercury solution described under "Reagents" to a digestion mixture containing HNO_3, reduced $KMnO_4$, and so on. The digestion mixture used for this purpose was one retained from a previous analysis, and all of the mercury had previously been extracted from it by dithizone. The purpose of using this type of solution as a basis was to simulate as closely as possible actual analytical conditions, impurities, etc. The reagent blank (that is, the amount of mercury introduced by the $KMnO_4$ and HNO_3, $NH_2OH{\cdot}HCl$ and H_2O_2) was eliminated, since this mercury had already been removed by the previous dithizone extraction. The blank for this group (runs 6 to 12 of Table VI) is therefore only the dithizone blank, thus is much smaller than the over-all empirical blank of runs 1 to 5. The variations in the dithizone blank in the series 6 to 12 are due to two things: (1) the analyses were run at intervals over a period of several weeks, and different dithizone solutions were used, and (2) the dithizone blank is proportional to the volume of dithizone solution used for extraction in the final stages. That is, if the blank for 10 ml. of dithizone has been found to be 2.6 micrograms of mercury, and 15 ml. of dithizone were actually used in an analysis to extract the mercury from the final aqueous solution, then the dithizone blank for that particular analysis would be $15/10 \times 2.6$ or 3.9 micrograms (correction method (1) described previously). The amount of dithizone solution used to extract the mercury in earlier stages of the analysis—e.g., from the digestion mixture, or from the ammoniacal iodide solution—is not to be taken into account.

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The information on pulp preservation presented in this paper was obtained from a cooperative project by Munksunds Aktiebolag, Lulea Trämassefabrik, Lulea, Sweden; Svenska Chemo AB, Malmö, Sweden; and Buckman Laboratories, Inc., Memphis, Tenn., U.S.A. Acknowledgment is made to Director Bure Holmbäck and Engineer Alf Alfsen, Munksunds Aktiebolag, for their general contribution of facilities and time during the course of the work, and to Manager Gustaf Hertzman and Engineer C. G. Jacobson for their assistance during the treatment of the pulp and subsequent examinations. Acknowledgment is made to Dr. Stig O. Pehrson, Svenska Träforskningsinstitutet, Stockholm, Sweden; Fil. mag. G. O. Gadd, Centrallaboratorium, Helsingfors, Finland, and Engineer Otto Bade, Papirindustriens Forskningstitutt, Sköyen, Norway. These men observed part or all of the treatment of the pulp and made helpful suggestions during the course of the work. The writer is particularly indebted for the work of Engineer Bade and Dr. Pehrson on the final inspection and classification of the pulp and also for the work done by Dr. Pehrson in making an isolation and generic identification of the resistant mold organism encountered during the work. However, it is understood that their presence does not imply either endorsement or disapproval of the preservative used or the methods employed by the men as individuals or the institutions they represent.

Appreciation is expressed for the helpful assistance rendered during the treatment of the pulp by Engineer Arne Overgaard, Jens Lange Lyche, Oslo, Norway; and Engineer Arnulf Nielsen, Brynolf Gronmark, Helsingfors, Finland; Dr. Clyde M. Christensen, Division of Plant Pathology and Botany, University of Minnesota, St. Paul, Minn., for the isolation and identification of the mold organism and for the microscopic studies of the growth of the mold on the pulp samples; Dr. R. N. Meals and Dr. J. W. Appling, Buckman Laboratories, Inc., for the chemical determinations of the retentions of BSM-11B; the method of analysis given in the Appendix; the mounts of bacteria, mold, and slime samples; and a critical review of the manuscript.

ASSOCIATION NEWS AND EVENTS

Report of the Secretary

R. G. Macdonald

The Technical Association of the Pulp and Paper Industry, reflecting the times, had an exceedingly successful year in 1948. The membership continued to grow at a rapid rate and several productive conventions were held. The work of the divisions and committees was very good in spite of the tremendous pressure of work on the committee chairmen and members by their companies during a record-breaking new construction and mill improvement year.

Membership

There were 424 individual members elected in 1948, 134 members resigned or were dropped. On December 31, 1948, the total individual membership was 3557.

There were 8 corporate and 14 sustaining members elected. Eight corporate and 4 sustaining members resigned. The corporate membership on December 31, 1948, was 205, and the sustaining membership was 176.

The following companies became corporate members in 1948:

The Bartgis Bros. Co., Ilchester, Md.
Cartiers F. A. Marsoni, Venozia, Italy
Fibreboard Products, Inc., Antioch, Calif.
Fleming & Sons, Inc., 1120 E. Clarendon, Dallas, Tex.
National Waterproof Papers, Inc., Front & Becket Streets, Camden, N. J.
Societe Landaise Des Cellulose, Tartas, Landes, France
Star Paper Mills Ltd. (England)
Star Paper Mills Ltd. (India)

The following companies became sustaining members in 1948:

Askania Regulator Co., 240 E. Ontario Street, Chicago, Ill.
Ciba Co., Inc., New York, N. Y.
The Drackett Co., 5020 Spring Grove Avenue, Cincinnati, Ohio
Farrel-Birmingham Co., Inc., Ansonia, Conn.
General Electric Co., Schenectady, N. Y.
Georgia Kaolin Co., 433 N. Broad Street, Elizabeth, N. J.
Hardinge Co., Inc., York, Pa.
Jackson & Church Co., Saginaw, Mich.
Kelco Co., 20 N. Wacker Drive, Chicago, Ill.
Lockport Felt Co., Newfane, N. Y.
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
Riley Stoker Corp., Worcester, Mass.
Rohm & Haas Co., Resinous Products Div., Philadelphia, Pa.
Virginia Smelting Co., West Norfolk, Va.

Necrology

The Association lost through death the following members:

G. K. Bergman, A/B Centrallaboratorium-Keskuslaboratorio OY
Mark W. Bray, U. S. Forest Products Laboratory
Paul deCosta Bray, University of Maine
Richard H. Dempsey, Rising Paper Co.
Thomas G. Finch, Alliance Paper Co. Ltd.
Charles E. Foley, Nashua Gummed and Coated Paper Co.
A. B. Hansen, Northern Paper Mills
George H. Harvey, Gardner-Richardson Co.
Bjarne Johnsen, Hammermill Paper Co.
Lester Kirschbraun, Flintkote Co.
F. P. Klund, Hammermill Paper Co.
George W. Mabee, National Folding Box Co.
Ralph B. Roe, Sorg Paper Co.
Carl C. Schneider, Hawthorne Paper Co.
N. L. Shamroy, Rust Engineering Co.
John Stadler, Consulting Engineer

Special Reports on Manufacturing Problems

As a year around service the Association makes a number of surveys. Some of these deal with information needed by committees but even more relate to problems of pulp and paper manufacturers who find occasion to check their own operating practices by finding out how similar practices are conducted by other companies in the industry. This so-called Service to Members Plan was initiated in 1921 at a time when there was but little published information on routine operations. In more recent years these problems have become more limited and specific since the more general routines have been published in the textbooks on Pulp and Paper Manufacture. The Special Reports issued by the Association in 1948 were:

No. 374 Groundwood Mill Equipment Survey II
No. 375 Process Water Used in the Manufacture of Alkaline Pulps
No. 376 Conditioning Cylinder Machine Felts and Wires
No. 377 Broke in the Manufacture of Book Paper
No. 378 Casein Substitutes
No. 379 Casein
No. 380 Use of Fadeometers
No. 381 Pulp Sampling at the Blowpit
No. 382 Groundwood Mill Equipment Survey III
No. 383 Groundwood Mill Equipment Survey IV
No. 384 Use of Weightometers for Wood Chips
No. 385 Use of Alum Solutions

Employment

Although a large number of members found new employment through the assistance of the Association there was neither a great surplus of jobs open nor men available. In 1947 there were many more jobs open than there were men to fill them. The slack was apparently taken up by the growing availability of men who were in the Armed Services and, after a brief refresher course in technical schools entered the industry in their old jobs or as newcomers. The large number of the latter was evident in the attendance at national and sectional meetings. The desire of the Association to assist in taking care of employment needs should be kept in mind. This applies in particular to paper mill superintendents, engineers, technically trained men and even mill operating managers, as well as sales engineers for the machinery and commodity industries. The Association does not require any fees for performing these very important services.

(*continued on page 36A*)

The Fall Meetings

Beginning in August the Association conducted six fall meetings, all of a functional nature. The attendance at all of them was satisfactory, and was composed almost entirely of individuals who had a vital and primary interest in the purposes of those meetings. The social aspects of the meetings were kept at a minimum and, in fact, did not exist in the form of dinners, entertainment, etc., at two of them. The serious aspect of the programs may have had some influence relative to the large proportion of individuals who were sent by their companies to attend the meetings. The attendance in general was somewhat higher than in 1947, not counting the exceptionally high one-day attendance at the Philadelphia meeting when a very large group attended as guests of the Pusey & Jones Corporation.

The Plastics Conference

On August 16–17, the TAPPI Plastics Committee sponsored a meeting at the Institute of Paper Chemistry at Appleton, Wis. E. C. Jahn of the New York State College of Forestry was general chairman. He was assisted by Herman Mark of the Polytechnic Institute of Brooklyn who led a symposium on "Resins to Fiber Bond" and by J. C. Pullman of the American Cyanamid Company who conducted a panel on "Plastics in Paper Converting." About 230 attended compared with 100 in 1947.

Fundamental Research Meeting

Because of the college recess period several meetings were held in August to accommodate university professors from all parts of the country who could most conveniently attend at that time. In August these meetings began with the Lignin Round Table conducted by the Institute of Paper Chemistry at Appleton. It was followed by a meeting of the Wood Chemistry Committee of the U.N.F.A.O. meeting near Cleveland, Wis., the TAPPI Plastics Conference, and on August 18–20 by the TAPPI Fundamental Research Meeting at the University of Wisconsin and the Forest Products Laboratory, Madison, Wis. Harry F. Lewis of the Institute of Paper Chemistry was general chairman. The program which was devoted to the theme "The Physical Properties of the Components of Wood" was directed by Alfred J. Stamm of the Forest Products Laboratory. About 160 attended.

Mechanical Pulping Conference

On September 27–29, a meeting taking on the proportions of an old time TAPPI fall meeting was held at Poland Spring, Me. This meeting was devoted to the Mechanical Pulping Process and was jointly sponsored by the Technical Section of the Canadian Pulp and Paper Association and TAPPI. John L. Parsons of the Hollingsworth & Whitney Company was general chairman and was assisted by G. F. Witty of the Canada Paper Company, and R. M. Drummond of the International Paper Company. At this meeting the status of all phases of groundwood manufacture was reviewed. About 300 attended.

Testing Conference

The TAPPI Testing Division sponsored an important conference at the Mellon Institute, Pittsburgh, Pa., on October 11–14. This was an all-work meeting during which the current problems relating to the TAPPI Standards were considered. James d'A. Clark was general chairman and about 120 attended. Although the problems considered were difficult and controversial, it was felt that the meeting served a much-needed purpose in breaking the "log-jam" that had developed regarding these methods because of the inadequacy of correspondence between committee members in dealing with them. Since these problems will undoubtedly get progressively more difficult there will be further need for such get-togethers to consider the technical aspects of them.

Third Engineering Conference of the Pulp and Paper Industry

The series of fall meetings was completed on October 25–28 at Buffalo, N. Y., with the Third Engineering Conference of the Pulp and Paper Industry. This meeting, which has become one of the most outstanding events of the year in the industry, was considered by many to be the best held to date and was attended by about 360 engineers. It was sponsored by the Westinghouse Electric Company. J. W. Hemphill of the Johns-Manville Company was general chairman. Plant visits were made to the Westinghouse, Lockport Felt Company, and Upson Company plants.

Fibrous Agricultural Residues Meeting

The Fibrous Agricultural Residues Committee sponsored a conference at Peoria, Ill., on November 15–16. S. I. Aronovsky of the Northern Regional Research Laboratory was general chairman of the meeting.

Publications

Although the publication practice of the Association followed the pattern of recent years definite plans were made to change some of these, beginning in 1949.

Technical Association Papers

Series 31 of Technical Association Papers will be the last volume to be printed. It will be superseded in 1949 by a monthly technical magazine. Since 1921 the meeting papers of the Association were published in the *Paper Trade Journal,* a weekly magazine owned by the Lockwood Trade Journal Company. At the end of each year these papers were collated and printed, together with considerable additional material in a cloth-bound volume called Technical Association Papers. Series 31 will contain 820 pages.

Tappi

The establishment of the new magazine to be called *Tappi* and the discontinuation of the use of space in the *Paper Trade Journal* was decided upon after discussions of the subject over several years. The former arrangement was mutually advantageous but there was a growing feeling that the Association could serve its members and the pulp, paper, and paperboard industries better by issuing its own magazine. The possibilities of performing a superior service appear to be very good and the times excellent for undertaking such an ambitious venture. The present Secretary who worked closely with the *Paper Trade Journal* since 1927 would like to express his appreciation of the courteous co-operation that he received over the past two decades from Messrs. George Macdonald, Henry J. Berger, and Tanyane of the Journal Staff who have died in the interim. They, together with Messrs. Lockwood, Gordon, Grosse, and other members of the Journal Staff greatly aided the Secretary in an important part of Association publication work.

Bibliography of Paper Making

Continuing his fine work as chairman of the TAPPI Bibliography Committee, C. J. West of the Institute of Paper Chemistry prepared a Bibliography of Paper Making and List of U. S. Patents covering 1947. These bibliographies, published by the Association, cover the technical literature of the industry since 1900.

Tappi Standards

Twenty-one standard testing methods were issued in loose-leaf form during 1948. Others prepared in 1948 will be issued early in 1949. It is unlikely that these standards will continue to be issued at the same rate as in preceding

(*continued on page 38A*)

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BIRD SCREENS

Big, modern Bird Screens have the capacity to deliver clean stock up to the limit of the paper machine to take it, at maximum machine speed.

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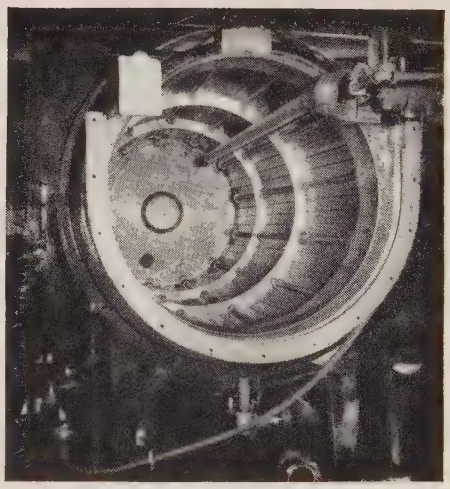

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(*continued from page 36A*)

years. The methods that are now under consideration demand much more effort in their preparation than those that were issued earlier. The Testing Conference already referred to illustrates the enhanced need for discussion.

It is doubtful if many members realize the amount of spade-work necessary to bring a method to the tentative standard status. Frequently, several years are required to process a single method. The need for a method has to be determined, then follows a number of approaches to the means of measuring a property, then there is the long period of experimentation and the establishment of reliability factors. There are many prospective methods in the dockets, most of which are not, at present, qualified to assume a "suggested method" status.

The need for some kinds of methods for evaluating products in process led to a roundup of so-called routine control methods. A large number of these have been collected and are at present being edited by R. C. Griffin, chairman of the TAPPI Standards Committee. These will be released soon in a form that will be useful but will not be confused with the more firmly established TAPPI Standards.

Tappi Data Sheets

No data sheets were issued in 1948 although several were prepared. These will be issued early in 1949. The early success of the C.P.P.A. Technical Section in preparing engineering data sheets led to the establishment of a similar service by the Technical Association. Behind the project was the recognition that every engineer accumulates files of basic material that he expects to find useful at some time, if not the present. The Association felt that it could contribute to this practice by acting as a clearing house to receive and publish valuable material in condensed and usable form. However, very little material has ever been received from members. The present content of the TAPPI Data Sheets represents selections made by members of the Association headquarters staff.

Recently, the TAPPI Engineering Division has had occasion to consider the merits of this service and plans are under way by the Division to revitalize this service and to make many new sheets available to the industry. A Data Sheets Committee is in the making and with this new vital force behind this project the original aim should approach attainment. An ultimate objective of this work should be an Engineering Handbook for Pulp and Paper Manufacture.

Tappi Bulletin

One of the results of the Association's new publishing policy was the termination of the TAPPI Bulletin. This publication was started as a wartime service and performed its job valiantly. Its ghost will be visible in the Association's new magazine. Ninety issues were published since 1942 and although it cannot be credited with winning the war it did much to co-ordinate the efforts of the industry and its grandchild, the packaging industry, in helping to do so.

Monographs

Two monographs were issued in 1948.

Monograph No. 6 "Nature of the Chemical Components of Wood" was sponsored by the TAPPI Fundamental Research Committee and consists of the presentations made at the Appleton Conference in 1947 which was organized, in part, to provide the material for this book. To Harry F. Lewis, and his colleagues, the Association owes a debt of appreciation for bringing this masterpiece of technical literature to fruition.

Monograph No. 7 "Pigments for Paper Coating" was prepared by the Subcommittee on Pigments, of which William R. Willets of the Titanium Pigment Company is chairman. This is one in a series of monographs being prepared by the TAPPI Coating Committee, Werner Kaufmann, Kupfer Bros. Company, chairman. They represent a tremendous amount of voluntary effort on the part of a large number of individuals. They are recognized as authoritative and are remarkable in that they have added to the industry's literature a large portion of the so-called secrets of a branch of the industry. If the secrets had not been generally known by the various companies there might have been some hesitancy in publishing them since it is the practice of the Association to only publish information that is contributed to it for the general welfare of the industry.

Tappi Medal Award

The 1948 TAPPI Medal was awarded to Dr. Emil Heuser, now of Downey, Calif., for his outstanding contribution to the advancement of the pulp and paper industry through his studies and reports dealing with fundamental cellulose chemistry.

Local Sections

No new local sections were established during 1948 although the Empire State Section established a branch in June known as the Metropolitan Group which meets monthly in New York City at the famous Fraunces Tavern. The Pacific Section again sponsored an outstanding seminar on fundamental wood chemistry, during which Dr. and Mrs. Holger Erdtman of Stockholm, Sweden, lectured. The Maine-New Hampshire Section sponsored the Mechanical Pulping Conference of TAPPI and the C.P.P.A. Technical Section at Poland Spring, Me. All sections returned to their normal schedule of meetings and had successful seasons.

Chairmen of local sections elected during 1948 were as follows: *Pacific*—Harold C. Wall, Longview Fibre Company, Longview, Wash.; *Lake States*—A. M. Heald, Marathon Corporation, Menasha, Wis.; *Delaware Valley*—John P. Weidner, Container Corporation of America, Manayunk, Pa.; *Kalamazoo Valley*—P. W. Bartholomew, Hawthorne Paper Company, Kalamazoo, Mich.; *New England*—C. H. Child, Merrimac Paper Company, Lawrence, Mass.; *Ohio*—P. S. Cade, Harding-Jones Paper Company, Excello, Ohio; *Empire State*—James E. Foote, B-F-D Div., Diamond Match Company, Plattsburg, N. Y.; *Maine-New Hampshire*—John L. Parsons, Hollingsworth & Whitney Company, Waterville, Me.; and *Chicago*—Warren Price, Applied Research Services, Chicago, Ill. *The Papermakers and Associates of Southern California* (Unaffiliated) elected Bruce F. Brown, Jr., Fibreboard Products, Inc., Los Angeles, Calif.

Divisions and Committees

The major technical work of the Association was carried on by more than 70 committees in seven divisions. The progress made by these committees in developing programs, working on projects, establishing standards and recommended practices, etc., is reported throughout the year by the chairmen and will not be summarized in this report. The following will be devoted principally to personnel changes during the past year:

Engineering Division: J. W. Hemphill, Johns-Manville Sales Corporation, general chairman. The division sponsored the Third Engineering Conference of the Pulp and Paper Industry at Buffalo, N. Y. Because of the fine work of this division a large number of power, maintenance, and construction engineers became members of the Association. *Steam and Power Committee:* J. E. A. Warner, Robert Gair Company, chairman; *Materials Handling Committee:* George R. Wadleigh, consulting engineer, chairman; *Drying and Ventilating Committee:* A. E. Montgomery, J. O. Ross Engineering Corporation, chairman; *Engineering Research and Machine Design Committee:* Philip H. Goldsmith, Pusey & Jones Corporation, chairman. At the Buffalo meeting a Hydraulics Subcommittee was established

(*continued on page 40A*)

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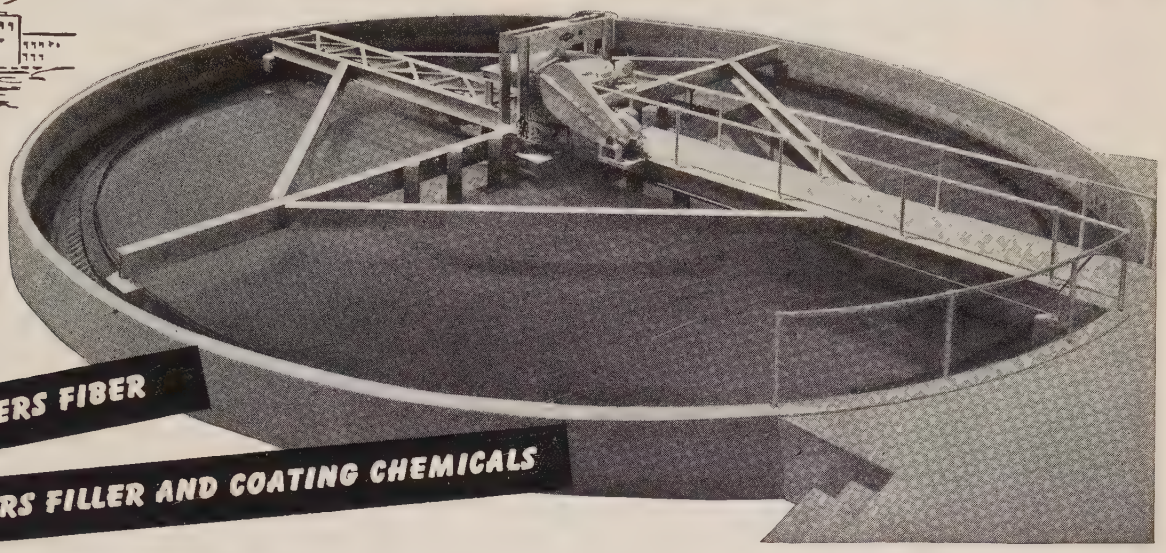

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The Dorrco Clariflocculator is a two-in-one unit providing mechanical flocculation coupled with continuous sedimentation and clarification . . . all in a single compact structure. In operation, solids are continuously withdrawn from a central sludge cone and a clear effluent is overflowed peripherally across a weir extending completely around the tank.

The case history at the right is based on Dorrco Clariflocculator operation at a large Wisconsin Paper Mill. At this mill, alum is added in the paper-making step to hold pH at 4.2 for best paper machine operation. Similarly, activated silica is used in a sufficient amount for best fiber retention on the wire. Consequently, no additional flocculating reagents are necessary, although in other cases they may be required for optimum results.

Regardless of the exact nature of your white water problem, there's a good chance that the ability of the Dorrco Clariflocculator to recover flotable and non-flotable material . . . *simultaneously* . . . may mean money in your pocket. Why not check with a Dorr engineer?

Name:_____ *

Equipment: One 30' dia. Dorrco Clariflocculator.
Flow: 300 gpm.
Feed: White water from paper mill. Solids contain 17–74% clay, starch, titania and other coating materials.
Chemicals Used: Paper Makers' Alum and activated silica.

Test No.	Solids—lbs./1,000 gal. Feed	Effl.	Sludge	% Recovery	Sludge % Solids
1	8.38	0.16	35.69	98.5	0.43
2	6.57	0.16	43.82	97.8	0.53
3	3.90	0.16	28.39	96.3	0.34
4	5.40	0.16	25.98	97.6	0.31

Comments: Pulp is sulphite and groundwood. Feed contains dissolved air tending to form scum but the flocculation effectively eliminates this problem and produces an excellent effluent.

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RESEARCH ENGINEERING EQUIPMENT

(*continued from page 38A*)

to study the factors governing the rates of flow of pulp and paper stock in pipes. K. G. MacKenzie, Eastman Kodak Company, became its chairman; *Mill Design and Economic Aspects:* Alvin H. Johnson, consulting engineer, succeeded Milton T. Jacobs, Chas. T. Main, Inc., as chairman; *Mill Maintenance and Materials:* George H. Pringle, Mead Corporation, chairman. This committee delegated two of its members to represent the Association in the National Association of Corrosion Engineers.

Industrial Division: Fred C. Goodwill, St. Regis Paper Company, succeeded Werner Kaufmann, Kupfer Bros. Company as general chairman. The present committee chairmen are: *Nonfibrous Raw Materials:* E. N. Poor, Hudson Pulp and Paper Company; *Vocational Education:* B. E. Lauer, University of Colorado; *Mill Instrument Control:* R. W. Porter, Fritz Publications; *Water:* Because of the illness of the chairman, Lewis B. Miller, University of Cincinnati, Miss Louise E. McGrath of the Booth Chemical Company became acting chairman; *Fibrous Agricultural Residues:* S. I. Aronovsky, Northern Regional Research Laboratory, chairman. The subcommittee chairmen were: *Procurement, Storage, and Preservation:* H. M. Blandin, Central Fibre Products Company; *Raw Materials Classification:* Dr. Aronovsky; *Pulping:* B. D. Stahl, Terre Haute Paper Company; *Board and Paper Manufacture:* M. F. Knack, River Raisin Paper Company, and *Testing:* N. F. Wilson, Alton Boxboard Company. This committee which is almost an association in itself sponsored a national fall meeting at Peoria, Ill.; *Structural Fibrous Materials:* John F. Campbell, The Flintkote Company, chairman. This committee was transferred from the Pulp Manufacture Division.

Converting and Consuming Division: Ralph A. Wilkins, Bird & Son, Inc., general chairman; *Containers:* W. B. Lincoln, Jr., Inland Container Corporation, chairman; *Graphic Arts:* R. H. Simmons, Government Printing Office, chairman; *Coating:* Werner Kaufmann, Kupfer Bros. Company, chairman. (The subcommittee chairmen are: *Adhesives:* Miss R. M. K. Cobb, Lowe Paper Company; *Mechanical Equipment:* F. W. Egan, consulting engineer; *Pigments:* W. R. Willets, Titanium Pigment Company; *Raw Stock:* W. A. Kirkpatrick, Allied Paper Mills; *Testing Procedures:* Miss Lois V. Hans, Hercules Powder Company; *Gummed Paper:* F. W. Farrell, McLaurin-Jones Company and *Wax Coatings:* J. D. Clark, D. L. Ward Company.) This committee sponsored the publication of TAPPI Monograph No. 7 "Pigments for Paper Coating" issued in 1948. *Plastics:* E. C. Jahn, New York State College of Forestry, chairman. (Its subcommittee chairmen are: *Resin Analyses:* T. A. Howells, Institute of Paper Chemistry; *Resins and Plastics:* Herman Mark, Polytechnic Institute of Brooklyn; *Resins for Paper Converting:* R. H. Mosher, Holyoke Card and Paper Company, and *Fabrication:* C. J. Straka, Westinghouse Electric Company, who succeeded N. R. Yorke, Panelyte Div., St. Regis Paper Company.) The Plastics Committee was transferred from the Research Development Division, as was the Wet Strength Committee, K. W. Britt, Scott Paper Company, chairman.

Research Development Division: G. J. Brahender, Marathon Corporation, chairman. The chairmen of the committees in this division are: *Bibliography:* C. J. West, Institute of Paper Chemistry; *Fundamental Research:* Harry F. Lewis, Institute of Paper Chemistry (this committee sponsored the fall conference on "The Physical Nature of the Components of Wood"); *Patents:* C. J. Rivise, Caesar & Rivise; *Statistics:* T. A. Pascoe Nekoosa, Edwards Paper Company; *Microbiological Control Methods:* J. W. Appling, Buckman Laboratories; *Chemical Engineering:* Roy P. Whitney, Institute of Paper Chemistry. The Plastics and Wet Strength Committees were transferred to the Converting and Consuming Division.

Pulp Manufacture Division: H. W. Bialkowsky, Pulp Div., Weyerhaeuser Timber Company, succeeded John A. Hanson of the Badger Paper Mills; *Acid Pulping:* George H. McGregor, Minnesota & Ontario Paper Company; *Alkaline Pulping:* K. G. Chesley, Crossett Lumber Company; *Mechanical Pulping:* R. M. Drummond, International Paper Company (this committee was a co-sponsor with the C.P.P.A. Technical Section of the Mechanical Pulping Conference held at Poland Spring, Me., in the fall); *Paper Deinking:* Frederic C. Clark, consulting engineer; *Pulp Purification:* W. D. Harrison, Riegel Paper Corporation; *Chemical Products:* W. P. Lawrence, Champion Paper & Fiber Company; The Structural Fibrous Materials Committee was transferred to the Industrial Division.

Paper Manufacture Division: A. L. Sherwood, Sutherland Paper Company, succeeded John A. Davis, Dill & Collins, Inc., as general chairman. *Preparation of Papermaking Materials:* Joseph J. Thomas, S. D. Warren Company, succeeded P. P. Gooding, Strathmore Paper Company, as chairman at the end of the year; *Papermaking (Cylinder):* James J. Harrison, Michigan Carton Company, succeeded O. E. S. Hedbring as chairman; *Papermaking (Fourdrinier):* B. L. Kassing, Ecusta Paper Company, resigned. No chairman was appointed in 1948.

Testing Division: James d'A. Clark, consultant, general chairman (this division sponsored a national conference at Pittsburgh, Pa., in the fall); *Fibrous Materials Testing:* E. R. Schafer, Forest Products Laboratory; *Nonfibrous Materials Testing:* Stephen I. Kukolich, Lee Paper Company, succeeded W. F. Hathaway, Kalamazoo Vegetable Parchment Company, as chairman (at the Pittsburgh meeting a subcommittee on Waxes and Microcrystalline Waxes was established with A. M. Heald, Marathon Corporation, chairman): *Pulp Testing:* Loren V. Forman, Institute of Paper Chemistry; *Optical Properties:* A. H. Croup, Hammermill Paper Company; *Container Testing:* W. J. Balster, Don L. Quinn Company, succeeded Mr. Quinn as chairman; *Packaging Materials Testing:* George R. Sears, Institute of Paper Chemistry; *Paper Testing:* B. W. Scribner, National Bureau of Standards; (*Erasing Properties Subcommittee:* P. W. Codwise, Beaver Wood Fibre Company, Ltd.); *Chemical Methods:* Milton Fillius, Eastman Kodak Company; (*Alpha Cellulose Subcommittee:* A. S. O'Brien, Eastman Kodak Company; *Disperse Viscosity Subcommittee:* Peter Van Wyck, Hercules Powder Company); *Microscopy:* Thomas Fyfe, Eastman Kodak Company.

Special Committees: *Standards Committee:* Roger C. Griffin, Arthur D. Little Company, chairman; *Research Appropriation Committee:* John L. Parsons, Hollingsworth & Whitney Company, chairman; *Joint Textbook Committee:* George E. Williamson, Strathmore Paper Company, chairman.

R. G. Macdonald, *Secretary*

Report of the Joint Textbook Committee

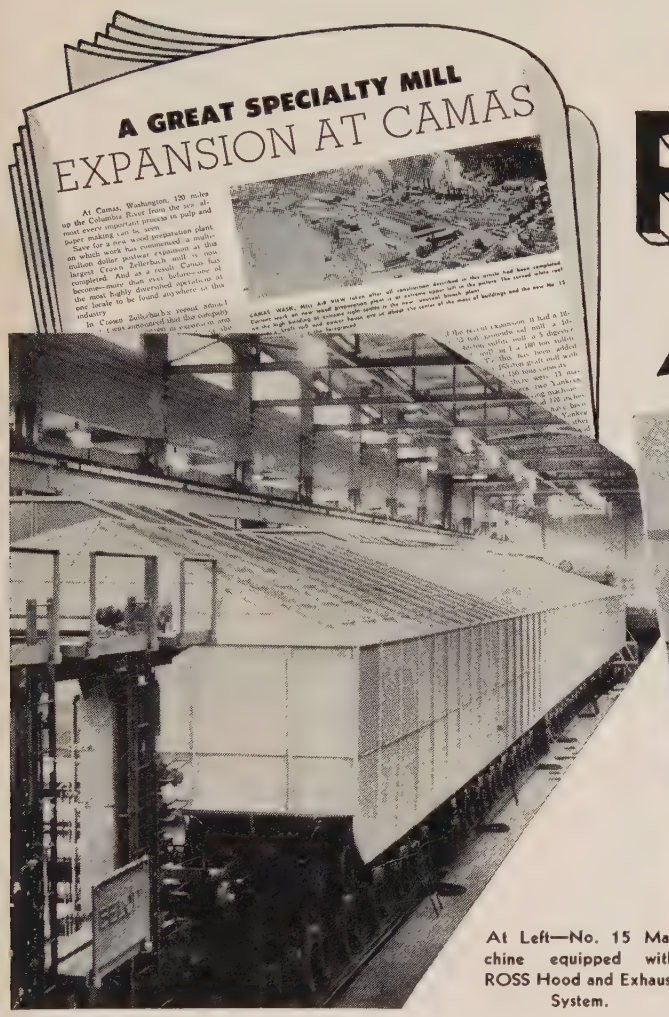
A complete revision of Volumes III, IV, and V has been under way for the past two or more years. All the new material plus topics not previously covered will be combined in 4 volumes under the general title of "Pulp and Paper Manufacture." Volumes I and II of the original series which deal only with the preliminary sciences necessary to the understanding of pulp and paper manufacturing processes, will not be revised and will eventually drop out of the picture, although there is still some small continuing demand for them.

In the new series, Volume I, entitled "The Manufacture

(*continued on page 42A*)

For Both Of The New Machines At *CAMAS*

CROWN-ZELLERBACH *selected*



ROSS
Air Systems

At Left—No. 15 Machine equipped with ROSS Hood and Exhaust System.

Above: No. 14 Tissue Machine equipped with ROSS Hood and Vapor Absorption System.

Another notable expansion and modernization program completed and again ROSS Systems are cast to play a leading role. At the Camas Mill, the industry's most diversified producer, ROSS systems include Hoods for both machines as well as for Kraft bleach plant washers; Yankee Vapor Absorption System and complete Machine Room Heating and Ventilating equipment. The most efficient utilization of air for processing in one of the largest specialty mills in the world.

ROSS SYSTEMS

J. O. ROSS ENGINEERING CORPORATION

MANUFACTURERS OF AIR PROCESSING SYSTEMS

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ROSS ENGINEERING OF CANADA, LIMITED, MONTREAL 19, CANADA • CARRIER-ROSS ENGINEERING COMPANY, LIMITED, LONDON, ENGLAND

(*continued from page 40A*)

of Wood Pulp," will be a complete unit in itself, and will have immediate sale upon appearance.

Volume II, "The Preparation of Paper Making Stock," and Volume III, "The Manufacture of Paper," are closely related and should come out as nearly simultaneously as possible. These two volumes should sell together.

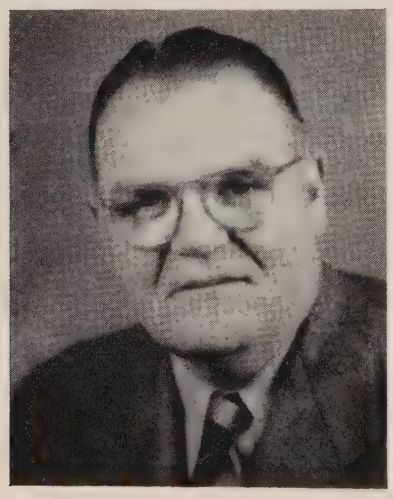
Volume IV, "Auxiliary Mill Equipment," is again a unit by itself and is likely to sell on its own.

The revision and complete rewriting of several of the sections of Volume I covering the up-to-date procedure in the manufacture and treatment of wood pulp, have required more time than previously was contemplated. However, the revised manuscript for Volume I is practically completed, and that for the other volumes is well in hand.

Editor Stephenson has experienced many difficulties and delays incident to getting the various sections written and reviewed by the best men in the industry. A careful final review of all the text was also being made by W. G. MacNaughton, Engineer in the Newsprint Service Bureau, prior to his death, so the end product should give the pulp and paper industry of the world the best assemblage of information upon manufacturing processes and equipment it has ever had.

R. S. Kellogg, *Secretary*

Report of the Tellers Committee

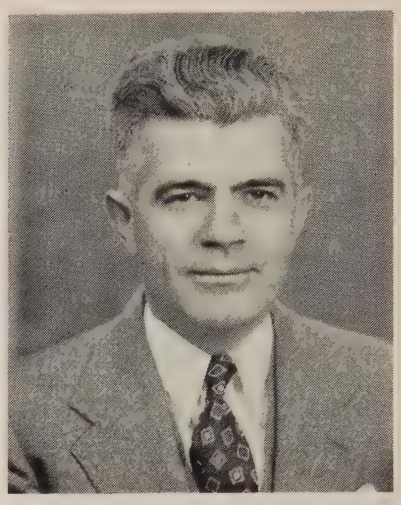


Albert E. Bachmann

W. Keith Gainer of the International Paper Co. and chairman of the Tellers Committee reported on the results of the mail ballot for election of Association officers. His associates on the committee were E. M. Engel of the Celanese Corp., and J. Rex Adams of Stein, Hall & Co. The officers elected were:

President: Albert E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt.
Vice-President: Kenneth P. Geohegan, Aetna Paper Co. Div., Howard Paper Mills, Dayton, Ohio.
Executive Committeemen (to serve three years):
James d'A. Clark, Longview, Wash.
Martin L. Downs, Thilmany Pulp & Paper Co., Kaukauna, Wis.
Werner Kaufmann, Kupfer Bros. Paper Co., Chicago, Ill.
George H. Pringle, Mead Corp., Chillicothe, Ohio.
Executive Committeeman (to serve one year):
Karl O. Elderkin, Crossett Paper Mills, Crossett, Ark.

Address of the President



W. F. Gillespie

Members of TAPPI and friends: As I see TAPPI's progress during the greater part of the last two years there has been no single major accomplishment that had not received recognition in some form in a previous year, and I doubt if there will be any major project completed next year to which this year's or some previous year's executive committee has not given some thought. The progress in building the TAPPI structure is not characterized by sudden flashes of accomplishment but rather by a planned steady growth continuing from year to year.

I am one of those who believe that the foundation on which the TAPPI structure is built is broad, thick, and reinforced and, with your permission, I want to organize and discuss with you for a few minutes some of the reasons why we have become a respected group nationally and internationally.

Members join societies to receive benefits therefrom. Fundamentally, we hope to gain—and rightly so. The benefits derived from TAPPI are derived from four main sources.

Meetings

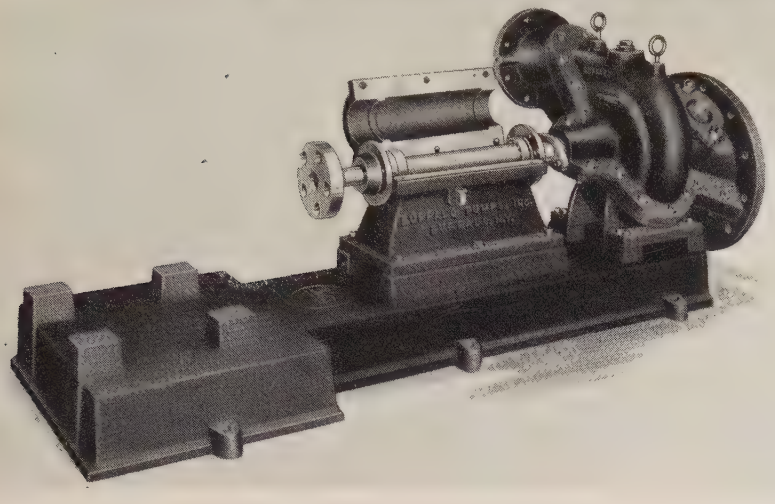
Within the week upwards of 1500 will register for our sessions. We come here for several purposes, but the motive is a profit one. There will be a number of outstanding papers and almost, without exception, we shall go back to our daily task with a new idea. Or, perhaps, we come to make contacts, and that will be profitable. Some of us come here to engage in strictly business deals. Some of us delight in the renewal of old acquaintances. And, while we are thus profiting, we should be conscious of the fact that it is TAPPI that is providing us this opportunity.

And let no one think that the effort that goes into such a meeting as this is trivial. It is a major project. Such an undertaking increases in difficulty with the years. It should be so. TAPPI could not be a static organization and meet the challenge of improving the standard as the years pass.

During the fall specialized meetings are held. The six meetings held this fall have each been masterpieces of organization and accomplishment. Plastics, Fundamental Research, Mechanical Pulping, Testing, Engineering, and

(*continued on page 44A*)

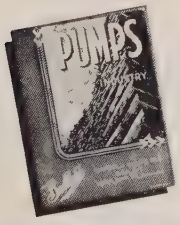
It's in the MAINTENANCE COST THAT "Buffalo" PUMPS SAVE YOU MONEY!



When your pump starts operating—that's when it either gives you the long, efficient service you wanted—or continual maintenance troubles that hold up important processes. Pick a "Buffalo" Paper Stock Pump and be SURE of saving where saving counts—ON UP-KEEP!

Handles Corrosive Stocks

Above is an example of a "special" pump that saves money on special liquids. It's the "Buffalo" Diagonally Split-Shell Rubber-Lined Pump. This rubber lining enables handling of chlorinated paper stock, concentrated hydrochloric liquids containing abrasive solids, and other corrosive liquids without harm to the pump—as well as maintaining the quality of the liquids handled.

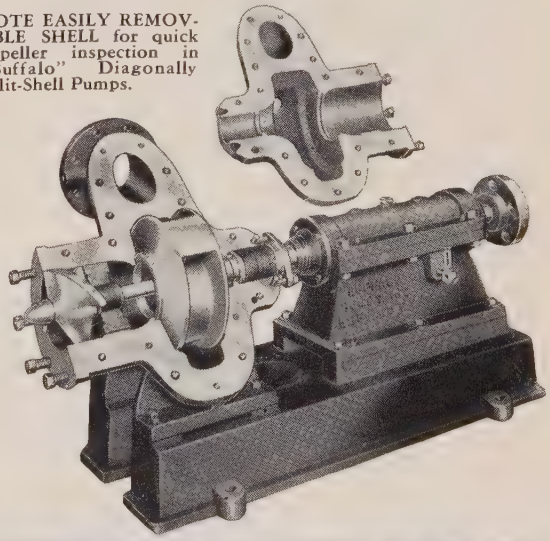


Write for Bulletin 953-F—pick the durable pump designed for *your* stock, *your* consistency, *your* conditions!

WHAT STOCKS DO YOU HANDLE?

"Buffalo" Pumps are all "special" pumps—designed in close coordination with paper men. For literally any liquid you pump—there's a "Buffalo" Non-Clogging Paper Pump that can handle the job smoothly. All "Buffalo" Pumps are built with an extra margin of endurance that pays off through years of hard service.

NOTE EASILY REMOVABLE SHELL for quick impeller inspection in "Buffalo" Diagonally Split-Shell Pumps.



PUMPS BY "Buffalo"

BUFFALO PUMPS, INC.

528 BROADWAY BUFFALO, N. Y.
CANADA PUMPS LTD., KITCHENER, ONT.
Branch Offices in All Principal Cities

"A Better CENTRIFUGAL PUMP for Every Service"

(*continued from page 42A*)

Fibrous Raw Materials groups attracted about 1400 registrants. I know they were good and so do those who attended. TAPPI provides the structure in which Ed Jahn, Harry Lewis, John Parsons, Jim Clarke, Bumps Hemphill, and Sam Aronovsky can organize their committees and provide such excellent programs for the specialized groups. I know TAPPI is grateful to them. I believe they appreciate TAPPI.

And, scattered about the country, are 10 local sections of TAPPI, each meeting regularly at intervals. From four to a dozen meetings are held each year by each section. The opportunities of meeting nearby friends and discussing mutual problems have again been largely the result of over-all TAPPI organization. A sincere and, I believe, successful effort in recognizing and solving the problems of local section and national TAPPI relations has been the task of Ken Geohegan. His efforts in this have been the subject of much favorable comment.

While discussing meetings, I want to call your attention to the Fall Meeting this year in Portland, Ore., on September 11–15, 1949. The Pacific section is sponsoring this meeting and already has done much organizational work. It has been arranged that there will be no conflicting meetings in the fall. It is to be hoped that our membership will accept the invitation and go to the Pacific Coast in large numbers, and those of you who do so will enjoy a profitable meeting in a delightfully hospitable part of our country.

By the examples just quoted you, some of us feel that TAPPI is adequately fulfilling one of the main purposes of technical groups in providing the opportunities for exchange of ideas.

Publications

Any scientfic society, such as ours, must have a strong publications policy. For many years, we have been able to point with pride to the literature that TAPPI has supplied its membership.

During most of these years an arrangement has been maintained with *Paper Trade Journal* to publish a technical section edited by our Secretary. It was with considerable regret that this pleasant association was terminated this year.

In its place you are offered our new magazine *Tappi*. We hope it will meet with your approval. It has been a major task to prepare it for you as scheduled. What you have seen is not perfect but with the talent that has offered help, I feel confident we are well on the way to having a publication of which we will feel proud.

One of the sacrifices that we had to make in our publications policy was the elimination of Technical Association Papers. This was done with considerable regret, as many of our members desire a bound copy of the Association activities at the end of the year. However, provision has been made that a number of bound volumes of the technical section of *Tappi* will be available to those who desire them at a nominal cost. You must, however, reserve a copy through the Secretary. Please do this immediately so you will not be disappointed at a later date.

You may also have noted that the contents of the new journal are so arranged that the binding of the technical section will be easily arranged for making a volume of approximately 600 pages at the end of the year.

I do want to emphasize that the membership as individuals, committees, local sections, and executive committees must share the responsibility in obtaining the continued improvement that we stated as our objective in this publication.

TAPPI Monographs now number seven. Each one is an excellent contribution. Seven more are in various stages of preparation. Two should be ready this year by the Coating Committee. Two more are very good possibilities. It may be found desirous to publish part of these in the new journal but, in either case, you have further evidence of an excellent publications policy.

We have announced previously that a loose-leaf binder will be published covering routine control methods. These are well along and it is believed they will be ready for distribution in the near future.

Our year book will continue to be an indispensable feature of our publications.

In meeting the second requirement of any scientific society, I feel that the TAPPI standard measures up well with any high standard you may care to select.

Services

But it is not sufficient to merely publish. There are other services which are necessary to supply the needs of the membership.

One of the greatest contributions that has been made is the setting up of the standards. This is considered by some groups as adequate justification for existence. TAPPI's contribution in this respect has been an outstanding one. Almost 200 standard methods have been contributed, covering a wide range of subjects. These standards are subject to continuous scrutiny and revision, and are being constantly improved as improvements are shown to be necessary. Many of our standards are accepted internationally. Others have been accepted by the armed forces and other scientific groups—a tribute to the quality of the work that has gone into the framing of these standards.

This year, for the first time, a meeting was held in Pittsburgh for the sole purpose of discussing testing methods with the objective of improving standards. The attendance of 160 technicians at this meeting was a tribute to the value of this important phase of our activities.

Over the years members have received almost 400 special reports that have been developed, largely, at the request of individual members. For the most part, these are the results of questionnaires sent out through the association office where they are assembled and edited and passed on to the interested members. A complete file of these represents an accumulation of information that it would be impossible to acquire in any other way.

During the war years, our association did an outstanding job. Many of you remember the Chicago and Boston meetings on packaging, sponsored by TAPPI. This is a problem of serious importance. One should not be praised unduly for doing one's duty, but I did want to mention this contribution as an illustration of what TAPPI can and will do when any special emergency arises. Within our membership we have the technical ability and we have an organization capable of concentrating our efforts where required most.

Most of you are familiar with TAPPI's contribution jointly with our Canadian friends in the publication of the best series of textbooks on pulp and paper making in existence.

Our close contacts with other scientific groups give us the means to pass on to our members specialized information as acquired.

The miscellaneous small services rendered our members through our association office become too numerous to mention.

In respect to services to members, I believe TAPPI has measured up well.

Investigations

I believe that a major part of a scientific organization's activities should be to foster original investigations and adequately finance them. I believe that in this respect TAPPI could do a much better job. Over a ten-year

(*continued on page 46A*)

from birch and aspen *now* come semi-chemical pulps

1

Partially cooked birch chips from digester—(actual size).

ABUNDANT and fast growing, these hardwoods are capable of vast increases over standard yields after sodium sulphite treatment followed by SPROUT-WALDRON refining.

Readily bleached and with high initial strengths, such pulps may be substituted for bisulphite in book and comparable grades.

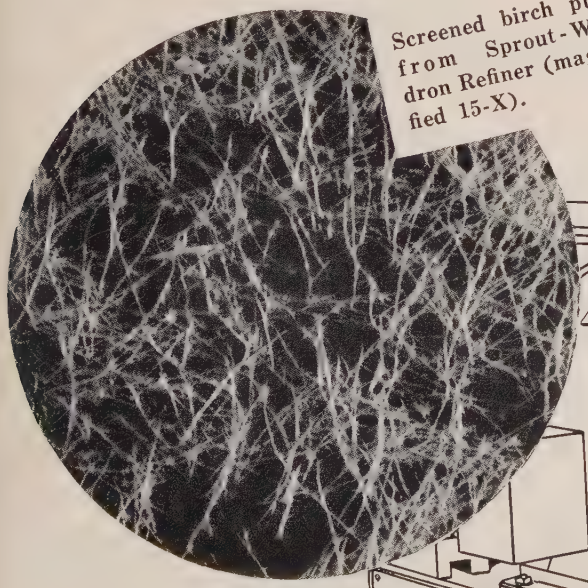
Low power and high increments of clean, uncut fibers, offer inducement to serious consideration.

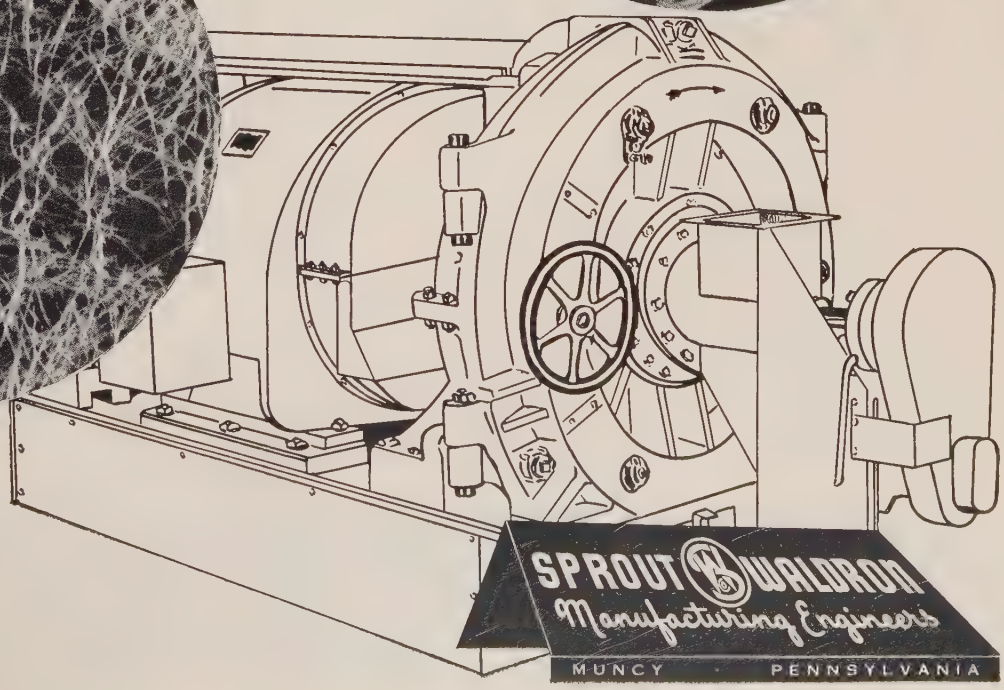
SPROUT-WALDRON offers you its technical knowledge and experience in consultation.

Sprout, Waldron & Co., 38 Waldron St., Muncy, Pa.

2

Screened birch pulp from Sprout-Waldron Refiner (magnified 15-X).





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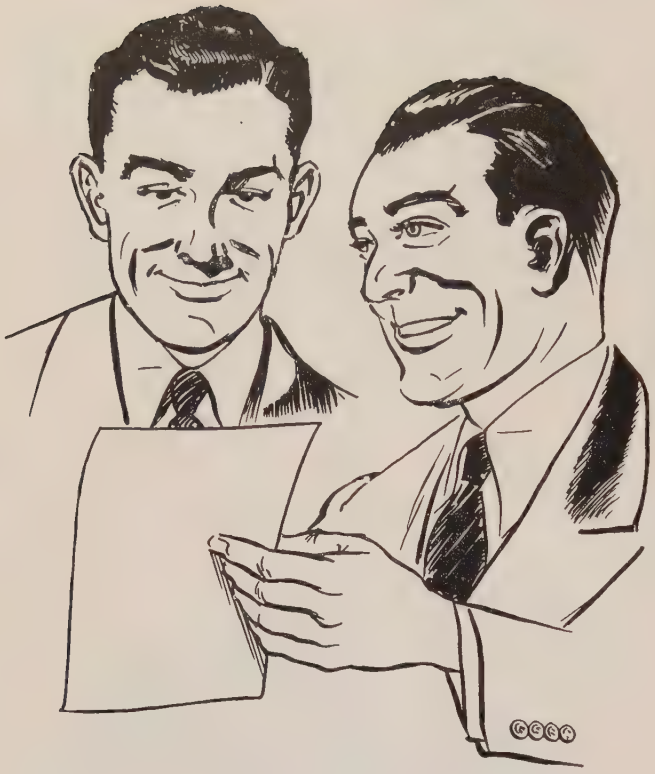


Back for More

At the end of the late war, one large newsprint concern had two Bauer Pulpers operating on screen rejects in two of its mills. Today those two mills have a total of 10 machines, and five additional Bauers have been ordered for a third mill. *Back for more.* These machines were purchased with a first-hand knowledge of what their returns would be. The extra quality of the fiber produced gives them a better sheet and each Pulper is turning out several hundred dollars' worth of valuable pulp each day from screenings.

A felt mill used five Bauers as refiners until 1947. Today they have twelve Pulpers fiberizing semi-chemically cooked chips as a partial furnish for their enlarged facilities. *Back for more!*

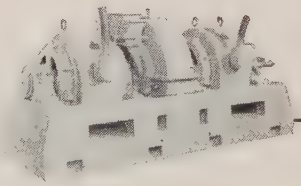
A towel and napkin plant installed one Bauer Pulper in January. By March they had purchased a second and were so pleased with results that by September they ordered 4 more. *Back for more!*

Satisfied users? YES! That's what brings them *BACK FOR MORE!*

For the production of long, pliable, free fiber from a wide variety of raw material sources for almost every grade of finished product, the Bauer is outstanding. The repeat orders above confirm that statement. Address your inquiry for detailed information to

THE **BAUER BROS. CO.**
SPRINGFIELD, OHIO

Bauer



period, appropriations aggregating less than $16,000 have been expended on 15 projects. For an association with approximately 70 committees, this is not enough.

I believe there are two reasons for this relative inactivity in a field which, I believe, to be an important part of TAPPI work. One of the reasons is that the committees themselves are not actively pushing the projects which they state as objectives. The other is that executive committees, at least those on which I have sat, have to take a conservative view relative to some of the requests that are made.

One might argue if one is the cause and the other is the effect, and which is which, but the net result is the same, namely, a lack of original investigation sponsored by committees. I should like to see the executive committee give earnest consideration to the solution of this problem and I believe there are approaches that can be made which will solve it.

Lest I should appear to be unappreciative of the outstanding contributions of several committees, let me hasten to say that I believe a considerable number are doing a perfectly magnificent job.

If TAPPI will bolster this phase of its acitvities, I believe it will round out a fourfold program that will make it a still stronger organization and thus enhance the respect with which it is held by the whole paper industry.

Next to the southern democrats, TAPPI ex-presidents belong to the most forgotten group in the country. I shall soon be a member of both groups. But, before I join the latter, may I take this opportunity of thanking TAPPI members for the privilege of being your president. I feel deeply indebted to you for the opportunity of serving. You have been kind and not often have you censured me for my many shortcomings. The happiness of making so many new friends among you will be a pleasant memory.

I have had the opportunity of visiting six of our local sections and from Maine to the Pacific Coast, I find that the paper industry contains a swell bunch of fellows.

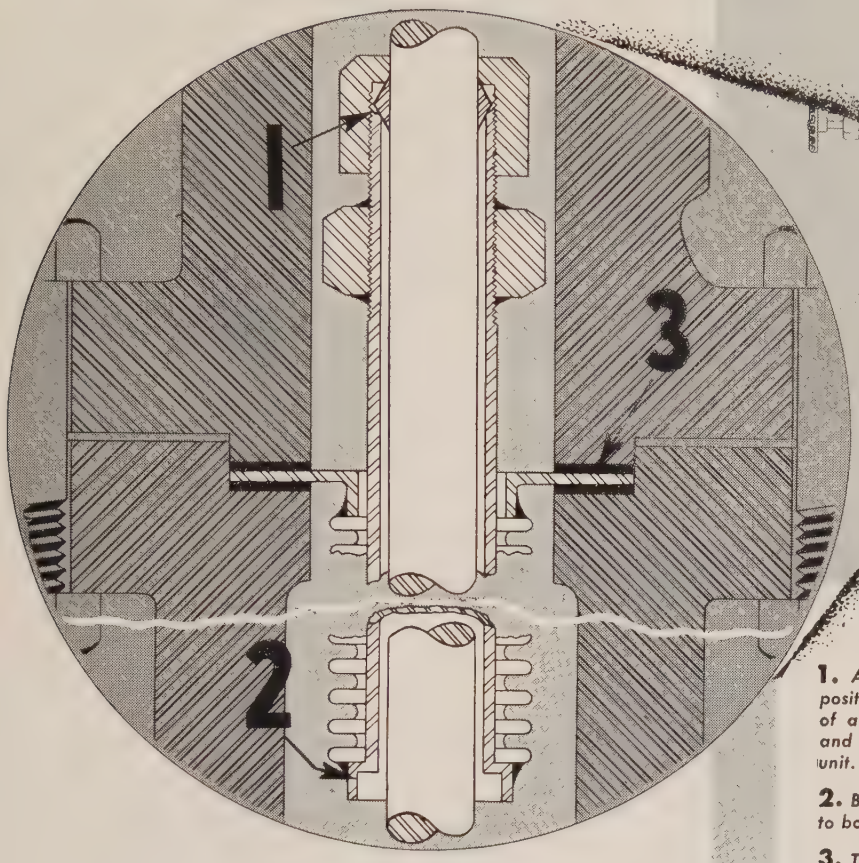
May I tell you, also, that in the executive committee, you have a group of thoroughly competent business men. They have traveled from all parts of the country at considerable sacrifice to attend executive committee meetings. We have had our arguments, but on more than one occasion has the loser in the argument worked the hardest to put across the idea that the majority approved. I can say, without reservation, that your executive committee is sincere in its purpose to do its best for the membership at large.

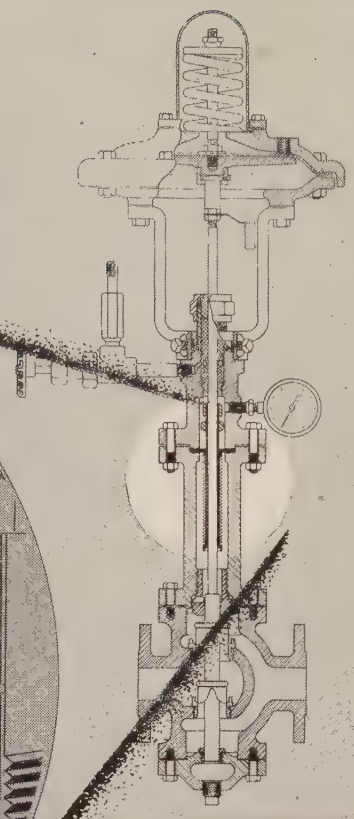
And, finally, may I pay tribute to our staff. To accomplish so much with such a limited personnel is in itself evidence of the energy and efficiency of Messrs. Macdonald, Bingham, and their associates. TAPPI is a fortunate organization in having Mac's leadership. It is a leadership with a wonderful background of experience, and contacts within and without the industry. His intimate knowledge of a maze of details does not hamper his broad view of association policies. It is not too much to say that the lion's share of the progress TAPPI has made over the years is the result of Mac's leadership.

And now, in closing, permit me to repeat that one of the most pleasant experiences of my life is the privilege you have accorded me in serving as your president, and please accept my sincere thanks for your tolerance and help during the past twenty months.

W. F. Gillespie, *President, TAPPI*

NOW! Stabilflo Valves with NEW, POSITIVE BELLOWS-SEAL





● Here's an automatic process control valve with a positive, safe, yet *simply-constructed* seal . . . for use wherever toxic, corrosive or precious fluids are involved. The Foxboro Stabilflo Valve is now available with a new-design, bellows-sealed valve stem. Instead of the conventional stuffing box, the packless bellows assembly makes a positive seal between the valve stem and valve body. The bellows expands and contracts with reciprocating action of valve stem.

Over the past eight years, Foxboro has pioneered in the development and application of bellows-sealed control valves for *special* jobs. This improved design is the outcome! It removes bellows-sealed valves from the class of "specials" because of its unique simplicity.

FEATURES

1. *A close-clearance liner guide is positively sealed to valve stem by means of a stainless steel compression ferrule and locknut. Stem and liner move as unit.*

2. *Bottom of liner guide is seam-welded to bottom of bellows.*

3. *Top of bellows is seam-welded to flange, which in turn is gasket-sealed between valve bonnet and bellows housing.*

Bellows assemblies are made of Type 347 Stainless Steel. *Replacement involves only the bellows and ferrule* . . . readily accomplished in field. Other distinctive features assure long service life.

The new-design bellows-seal assembly can be applied to any standard Stabilflo Valve in sizes through 4 inches.

See how many advantages involving safety and economy are offered you by this new development. For complete details write **The Foxboro Company, 78 Neponset Avenue, Foxboro, Mass., U. S. A.**

FOXBORO REG. U. S. PAT. OFF. **INSTRUMENTATION**

REPORTS AND DISCUSSIONS

Presented at National and Regional Conferences

Condensations of Annual Meeting Papers

Following are condensations of a number of the papers that were presented at the annual meeting of the Technical Association (February 21–24, 1949). Most of these papers will be published in full in subsequent issues of *Tappi*. These condensations have been selected because they contain data of immediate interest. Others, of a more general nature, have been omitted but the complete text will be published if approved by the *Tappi* Editorial Board.

Statistical Control of Paper Quality—1. Basis Weight and Moisture Content, Charles M. Koon and W. F. Pease

In a sulphite bond and specialty mill, modest but encouraging progress has been made toward the statistical control of basis weight and moisture content. Over a period of three months' operation on one machine, Shewhart control charts have been applied with some success to all runs which were 15 hours or more in duration.

Three advantages in the use of the control charts have immediately become evident: first, the charts have illustrated clearly the effect of basis weight fluctuation on uniformity of moisture content—a relationship which the operators had taken for granted, but which the supervisory personnel had not fully appreciated. Second, the charts have helped to emphasize the undesirable effects of equipment deficiencies whose influence had been known perhaps qualitatively but not quantitatively. Third, on most paper machines, the skill and judgment of the operators are the final factors which determine how uniform the basis weight and moisture will be. The control charts contribute to this skill, because they replace the operators' intuition, and arbitrary tolerances which are so often established, with practical, realistic limits based upon past performance of the same machine. These limits can eliminate most of the guesswork from basis weight and moisture control.

In spite of these advantages, the operators have been rather slow to utilize fully the information which the control charts provide. This apparently is not due to any unwillingness on their part to co-operate but rather to their lack of complete understanding and appreciation of this new tool which has been offered to them. The need for further co-operative efforts on the part of the supervisory personnel is therefore indicated.

Wet Strength Paper Problems, Börje Steenberg

A review is given of the physical chemistry of melamine and urea formaldehyde resins as used for wet strength paper production. The need of further research with respect to urea resin seems urgent, because of the low retention figure of this resin.

Mention is made of the choice of different types of these resins when using different fiber furnish. The conventional way of expressing wet strength as per cent of the dry strength does not properly characterize the unique properties of the wet strength paper. Dry paper is a strong but relatively brittle material. Wetted wet strength paper is a soft and tough material. The mechanical properties of materials so differently behaving cannot be compared by tensile strength data alone. The theoretical interpretation of wet strength mechanism is discussed in the light of stress strain experiments which show that wet vegetable parchment and wet strength paper is very similar in behavior. Some experiments on the properties of wet cellophane and on strips of a fairly high molecular bacteria cellulose sheet are used for comparison with wet strength papers.

Further studies on the degradation of the wet strength effect by hydrolysis of the resin are required as well as of means of overcoming sizing effects when such are not desired.

The Kenwood Wheel as an Operating Tool, Irving H. Peters

A running papermakers' felt on a board machine will change in length by an amount proportional to the magnitude of the load to which it is subjected. The amount of these length changes can be determined with the aid of a simple measuring instrument called a Kenwood wheel. Excessive length changes adversely affect felt life.

The change in felt length when measured just before and just after any unit which is applying tension load to the felt (such as a press, for example) is a direct indication of the amount of load being applied. By making a "stretch curve" (a series of measurements before and after each load application point on the machine) it is possible to locate sources of undue strain or excessive load on the felt. These excessive loads can be reduced by doing a number of things which will lessen the number of pounds of force required to overcome the load applied to the felt. The operation of helper drives is a most important factor in helping to eliminate excessive felt tension load.

The felt stretch curve is the only simple way of actually determining what the various tension loads are on the running machine. On machines having electrically driven helper motors it is essential to know the magnitude of these various tension loads in order to operate drives so that an amount of tension load remains which is just sufficient for proper operation.

Curlated Pulp—A New Approach to Pulp Processing, H. S. Hill, J. Edwards, and L. R. Beath.

A permanent change in the shape of pulp fibers is obtained by causing nodules of high consistency pulp to roll in changing directions between two surfaces which compress the nodules while they roll. The change in shape is toward more bends, kinks, and twists and a more tubular cross section. The manipulation also exerts a powerful deshiving action.

The process causes a change in all pulp properties and, while there are many degrees and variations, the effect in general is toward a softer pulp and thus is somewhat opposite from the effect of beating. Freeness tends to rise. In appearance sheets of the treated pulp take on a more even-textured, matte look. The process effect is in evidence applied at any degree of beating, and to some extent persists through subsequent beating. The process effect resembles that of drying in regard to strength properties but differs for stretch, drying tending to lower stretch, and the process to increase it strongly. The process widens the range of quality obtainable from a given pulp, and also permits entirely new combinations of pulp properties, thus indicating a wide variety of possible application. Among other things, it may permit a higher pulp yield for many conversions.

The Curlator—Its Application to High Yield Newsprint Sulphite, Frank P. Silver

The Curlator, a radically new type of pulp processing equipment, is described. An account is given of its first commercial trial which was in a hook-up in a newsprint sulphite system to permit an increase in pulp yield. The Curlator was put on the screen rejects in a closed system, and then the digester yield increased in steps until the amount of rejects reached the full capacity of the Curlator to treat them properly. About 10% increase in yield was obtained with practically all of the digester yield accepted to newsprint. The results were entirely satisfactory from operating and quality standpoints, and the equipment and method were thoroughly proved out during eight months of steady operation. The Curlator treated 30 to 45 tons of screen rejects per day at 1 to $1^1/_2$ hp./day ton. On the basis of the present trial, materially higher yields are envisioned, with Curlators treating the whole sulphite stock.

Elimination of Suction Roll Noise, John P. Nash

The combined efforts of the Kimberly-Clark Corporation and the Beloit Iron Works have resulted in a workable silencer for suction rolls. This silencer, invented in 1937 by E. J. Abbott and J. D. Kraus, provides an air gap on the leaving edge of the suction box so that air must enter the evacuated holes of the shell slowly, the pressure wave which causes the noise in unsilenced rolls being thereby eliminated. It was long thought that this silencer was impractical for continuous mill operation, but further investigation has revealed that it can be installed successfully in the suction rolls of creped wadding machines. Installations have been made with excellent success on eight Kimberly-Clark creped wadding machines, loudness reductions of more than 80% being obtained on some rolls, and it is believed that similar results can be achieved on paper machines.

Fast Cementing of Leather Belting Laps on Paper Mill Machinery, Samuel L. Allen

This paper describes a method and the necessary equipment for accelerating the drying of waterproof nitrocellulose cement

(*continued on page 50A*)

Lodding Creping Doctor in action on "Mister Nibroc," Brown Co., Berlin, N. H. Lodding Engineering Corporation, Worcester, Mass. Represented outside New England by W. E. Greene Corporation, Woolworth Building, New York.

(*continued from page 48A*)

with infrared light in the lap of a leather belt when it is installed or shortened. It also summarizes the tests on which the method is based. Studies were carried out on a semiplant scale and showed that a minimum press board time of 10 minutes can be used and that the drying time should be approximately 30 minutes per ply of leather.

The laboratory work involved studying the strength and speed of drying of various cements and such other factors as effect of viscosity, degree of nitration, per cent solids, various plasticizers, and formulation of solvents on the most promising cements. It also correlates the quality and strength of a lap with the press board application time and the drying time with and without the use of infrared light.

Adaptation of the B.O.D. Test to Pulp and Paper Mill Wastes, Harry W. Gehm

Uses, advantages, and shortcomings of the B.O.D. test are discussed in relation to its use in respect to pulp and paper mill effluents. Recommendation regarding modifications and application to specific pollution problems is made and results of oxidation rate tests made on several pulp and paper mill wastes by this method reported and compared to the established rate for sanitary sewage. The rate of oxygen consumption by aerobic decomposition of various types of fiber is compared and data concerning the effect of fiber on long-time B.O.D. rates are presented.

Some Recent Developments in Evaluating the Biochemical Oxygen Demand in Streams, F. W. Kittrell

Biochemical oxygen demand (B.O.D.) and dissolved oxygen (D.O.) determinations reveal the condition of polluted streams and are useful in predicting results of reduced waste discharge. An idealized example of the method of using these tools is presented. Practical difficulties met in application to stream examination and evaluation, due to numerous variables in natural streams, and suggestions for minimizing them, are described. These difficulties, imperfect understanding of the fundamentals involved, and a tendency to apply generally accepted concepts indiscriminately to all types of streams, have combined to discredit the method. Recent developments, which provide explanations for past unsatisfactory experiences and give promise of more acceptable results in the future, are described. Pending further development, it is suggested that empirical rather than theoretical methods of interpreting B.O.D. and D.O. data may be utilized.

The Technique of the Biochemical Oxygen Demand Determination, D. Paul Rogers

The antistream pollution program in Pennsylvania has created a very active interest in the determination of the biochemical oxygen demand among industries and municipalities, because it is the most important measure of pollution from sewages and industrial wastes entering streams.

Some chemists still report the highest B.O.D. value obtained among the various concentrations; some record the lowest; some give the values of all the concentrations; and some take the average value of the concentration. This chaotic condition of reporting results makes evident the need for a uniform procedure so that comparable results may be obtained not only in the laboratory but also among different laboratories.

The determination of the biochemical oxygen demand with its arbitrary factors is understood here to be the amount of dissolved oxygen required by the mixed population of organisms in a sample incubated for 5 days at a temperature of 20°C. and expressed in terms of a 50% oxygen depletion.

The test under normal conditions must proceed without any interruption due to the presence of strong acids, caustic alkalies, salts that affect the dissolved oxygen content, salts that inhibit or hamper the liberty of the organisms, and bacteriocidal substances in excessive amounts. If these interferences are present, certain things must be done to eliminate their effects.

In the technique of the determination, suggestions for choosing concentrations, making of dilutions, determining the dissolved oxygen before and after incubation, a simplified calculation of the final B.O.D. in terms of a 50% oxygen depletion are set forth in detail together with tables and examples.

Some industrial laboratories including several paper mills in conjunction with the state laboratory have shown that this procedure is successful. The additional arbitrary factor of expressing the final B.O.D. of the sample in terms of 50% oxygen depletion satisfies the demand for uniformity in the method for obtaining reproducible and comparable results.

Re-seeding B.O.D. Bottles—A Means of Detecting Toxic Interference in the B.O.D. Test, George C. Borden, Jr., and Irene Woodcock

Paper mill effluents may contain substances which are inhibitory or toxic in their effect on bacterial organisms. Such biologic organisms in the progress of their normal metabolism establish the foundation for the biochemical oxygen demand test. A substance which through inhibitory influence distorts the rate of metabolism also distorts the B.O.D. determination deriving from that metabolism. By the means now available it is not always possible for B.O.D. analysts in paper laboratories to be positive in their detection of toxic interference.

Re-seeding is a method designed to provide the average analyst with a technique for the detection of interference with normal metabolism. Two schedules of re-seeding were experimented with; one introduced the new seed in progressive quantity throughout the incubation period; the other introduced new seed twice during the first 48 hours of incubation.

Graphs are presented showing the operation of the technique in cases of total and partial toxicity. Plain waste as well as treated waste was re-seeded in all cases. The results of such re-seeding on plain waste offer interesting data on the effect of seed kind and seed quantity on the velocity of the B.O.D. reaction. The effect of re-seeding treated waste shows how, by comparison with the plain waste, toxicity may be determined.

The technique employes a system of duplicate bottles and gives a method of introducing new seed in a way which does not disturb the equilibrium of the B.O.D. reaction.

Stream Pollution from Virginia Pulp Mills, A. H. Paessler and L. L. Hedgepeth

The State Water Control Law is discussed briefly with a statement of its purpose and an explanation of the provisions it makes for controlling pollution. The status of municipal and industrial pollution is presented by means of maps showing the number of persons discharging treated and untreated sewage into each river basin, as well as the number and type of each industry discharging wastes.

The pulp mill pollution problem is discussed. Use of the biochemical oxygen demand test is shown as one of a number of useful tools in determining the extent of this problem. It is stressed that factors other than B.O.D. are of equal or greater importance.

The method of accomplishing pollution abatement does not usually concern regulatory agencies, but it is a matter of much concern to the mills. An example of the regulatory agency's conception of a typical pulp mill pollution problem is shown.

Fire-Retardant Coatings, Nathaniel Altman

Public concern over fire hazard in buildings, and the ever-mounting loss of life and property through fire have prompted a broad program of building-code revision directed toward the elimination of flammable construction materials. Manufacturers are faced with the necessity of incorporating adequate flame resistance in their products, at the same time retaining or improving other characteristics. The use of fire-retardant coatings, applied either in the fabrication of these building materials or in the field, is the most practical answer.

The development of fire-resistive surface treatments in general is outlined briefly, and the accepted theories of how flame-retardant chemicals function are discussed. Every type of coating considered to have any measure of effectiveness is described, compared, and its individual characteristics noted.

Detailed consideration is given to Albi-"R," the most effective coating now available, and to the principles involved in its superior performance under fire. Mention is made of its impressive test and field record, and of present efforts to adapt the Albi principle for production coatings applicable by plant processing methods.

Evaluation of Fibrous Agricultural Residues from Structural Building Board Products. II. Fundamental Studies on Wheat Straw Fiber, E. C. Lathrop and T. R. Naffziger

A fundamental study of the relationship between the fiber properties of wheat straw and the physical characteristics of insulation boards made from them has led directly to the conclusion that wheat straw is highly suitable for the manufacture of meritorious products. Methods are described for cooking and refining wheat straw to produce mainly long fibers and also hydrated short fibers. A means of fractionating long straw fibers into various fiber lengths is described. An analysis of the physical properties of insulating boards made from hydrated, filler, and selected long straw fiber has shown that long fibers favor the production of boards of flexural and tensile strengths higher at any comparable densities than wood fiber boards. The impact strength of such boards is two to three times that of wood boards. Tensile strength of such wheat straw boards is directly related to hydrated fiber content, while impact strength is directly related to fiber length, although fiber diameter may also play an important role in impact strength.

Electronic Water Penetration Tester, P. E. Marenholtz

The current practice of making water penetration tests by

(*continued on page 52A*)

BOARD COA

WATER EMULSION PAIN

WATER

SHOE DRESSINGS

EX COMPOUNDS

PAPER SIZING

PAPER COATINGS

OARD

RUBBER TIRES

PLYWOOD ADHES

OTGUN SHELLS

ORTHO PROTEIN

The new isolated soybean protein for INDUSTRIAL USE

Drackett Ortho Protein is the new isolated, soybean protein for industrial use. The product is granular, light cream in color and odorless. Production is accomplished by first removing the oil from soybeans leaving a high protein content meal. Ortho Protein is then obtained by extracting the alkaline soluble protein fraction from this meal.

The finished product is composed of various amino acids linked together in the form of a natural high polymer. Its chemical structure is one of the most complex encountered in the high polymer field. In dry form, as shipped, it can be stored for a reasonable period of time without appreciable change in its characteristics. Ortho Protein is produced to several specifications. The principal variable between the specifications is the viscosity rating. It has been determined in industrial uses that for each application there is an optimum viscosity.

Industrial demand for isolated protein has grown rapidly in recent years and continued research resulting in improved quality has greatly extended its use. The offering of a protein made to a variety of exact specifications has revealed a broad market both in industries where it is now being used and in others where it may be adopted.

PROTEIN DIVISION
THE DRACKETT PRODUCTS COMPANY
5020 Spring Grove Ave., Cincinnati 32, Ohio

(*continued from page 50A*)

means of the dry indicator method has been found to be unsatisfactory both from the standpoint of accuracy and convenience. More accurate test methods have been developed, but a simpler and faster method is needed.

The Electronic Water Penetration Tester was developed in an effort to answer these needs. It provides an automatic means of registering the time required for water to penetrate a specified depth into the board. The electrical conductivity of the penetrating water is utilized to close an electric circuit. A needle acting as an electrode is inserted into one face of the sample to such a depth that its point is a specified distance from the opposite face which is exposed to water. The instrument is provided with a running time meter which is started at the beginning of the test. At the instant the penetrating water reaches the needle point, the running time meter stops and a signal light in the instrument is turned on to indicate that the test is complete. This instrument and method offer the advantage of being entirely automatic after the test is started. The final meter reading may be taken at any time after the test is complete. A series of tests on several different brands of insulation board were conducted. Water temperature was varied from 100 to 130°F. during the tests.

Studies in Water Resistant Pastes, Edward H. Hill and Valentine X. Sliwinski

The rating of the pulp and paper industry in sixth place and how it has grown during the last forty years to where two million people in the United States depend on it for a living is shown. Paste problems are prevalent today that did not exist a few years ago because of the new and better uses of paper for enjoying the worthwhile things in life. People in the United States consume about 350 pounds of paper per person yearly, while all others consume about 10 pounds per person annually.

The need for a water resistant paste is shown, and some of the work done on this subject by the industry is brought out. However, this seemed insufficient, so special cooks to determine the correct temperature, cooking time, kind of materials needed, pH during the cooking and of the finished pastes, etc., are investigated. So that the value of different pastes can be determined, tests for measuring these are discussed.

From the data assembled in this study, definite conclusions are drawn. Maximum water resistance is obtained by cooking the U.F. resin, starch and/or dextrine together with 5.0% sodium chloride and 1.0% hydrogenated fat, based on starch weight, to a temperature of 195°F. for 15 minutes. Data are given to show that if the salt and the fat are used together a paste will be made that will have a long pot life. One of these alone will not be completely satisfactory. The data did not show any great advantage from cooking the U.F. resin, starch, or dextrine with an acid salt, so the pH will be below 5.0 at the end of the cooking period. The tack of the paste can be improved by substituting dextrine for part of the thin boiling or thick boiling starch. When this is done, however, the water resistance of the paste decreases in proportion to the amount of starch replaced by the dextrine.

White Water Clarification of Coagulants Used in Flotation Process of the "Savalla" Vacuum Saveall, B. Niberger and R. E. Bodette

The flotation principle brought about in the vacuum tank of the Savalla Saveall is based on the theory of paper sizing developed by R. Lorenz with the exception that air is injected in the incoming white water. Because of the vacuum of about 8 inches working on the aerated water comparatively small amounts of chemicals are needed to obtain proper flotation. The fiber blanket formed in the tank flows, undisturbed by any mechanical device, over a dam, whence it is drawn off by a combination 3-hp. vacuum-stock pump, which is the only moving part on the whole apparatus. The clarified water runs off by gravity.

The following coagulants have been and can be used in the process: aluminum sulphate, sodium aluminate, caustic soda, rosin size, animal glue, calcium oxide, Turkey red oil, pitch, and synthetic resins. When choosing the type of coagulant to be used in this process the chemicals already used around the mill must be given preference. By doing so introduction of additional chemicals can be avoided.

The high efficiency in recovering suspended solids from the white water and the possibility of selecting the most suitable coagulants result also in a high degree of B.O.D. reduction. Five-day B.O.D. tests by independent laboratories have shown reductions of well over 90%.

A Savalla unit, capacity 800 to 1000 gallons per minute, size about 20 feet long, 11 feet wide, and 14 feet high, was recently put into operation at the St. Regis Paper Company plant in Deferiet, N. Y. This unit is recovering approximately 8 tons of valuable fibers and fillers a day, the recovery efficiency being about 98% on average. Three different types of glue and 70% solids rosin size, were tried successfully. Alum was used continuously on the paper machine. The groundwood content in the sheet was from 60 to 70%.

The recovered stock is of fairly light consistency, usually ranging from about 40 pounds per 1000 gallons up to around 100 pounds per 1000 gallons depending on the amount of solids contained in the incoming white water. This stock is taken back direct to the fan pump on the machine without causing any trouble, and it only takes 10 minutes to return it to the paper machine. This same method has been in use for about three years in Europe but is now applied in the United States for the first time.

The unit is not overly sensitive to normal pH changes in the white water and permits normal variations in consistency and volume without need for resetting the chemical dosage.

Flocculation for Flotation as Employed in the Sveen Pedersen Flotation Saveall, Paul Easton and R. A. Baum

A brief discription and history of the Sveen Pedersen Flotation saveall and the flow principles employed is presented. The development of the Sveen glue as a flocculent and its adaption to the principles of flotation are covered. The mechanism of collection and flocculation of fiber and filler by Sveen glue and aluminations are covered, as well as recent improvements in the basic glue formula and modifications to suit specific operating conditions. A second major flocculation employed in the Sveen Pedersen Flotation savealls is activated Silicasols. The mechanics and principles involved in the use of this recent development are presented. Other flocculents that have not been generally accepted are covered in brief.

Stream Improvement—Settling Pulp and Paper Mill Waste Waters and Dewatering Bulk Solids, August S. Erspamer and William D. Rice

The solution of a waste disposal problem can be most efficiently attained by a series of progressive steps. Since the most effective and usually the least expensive methods of waste disposal are preventive measures, efforts were first concentrated on means of reducing the usage of fresh water and making more use of white water. Surveys were carried out and detailed flow sheets made showing source, volume, and type of water used. A program was set up whereby education of operating personnel, reporting of lapses in proper mill operation, improvements in plant operation, and elimination of leaks and unnecessary wastes considerably reduced the volume and quantity of the pollutional load. In a two-year period a 20% reduction in the volume of waste and an appreciable lowering of the solids load were realized. In spite of all mill improvements, and reduction of pollutional load by "inside treatment," there remains a large volume (ca. 6.5 million gallons per day) of waste which requires "outside treatment." In order that a method may be devised to make such treatment most effective and within economic range, a pilot plant was constructed and put into operation. The pilot plant tests were carried out on the stabilized mill wastes to obtain information on sedimentation (with and without mechanical flocculation) which could be applied to a process for treating the wastes. Plain settling effected a reduction of 60% in turbidity, 85% in suspended solids, and up to 98% in settleable solids. The optimum settling time was found to be 2 hours and mechanical flocculation had but a slight effect. The studies also included investigations on sludge disposal covering both lagooning and filtration on an experimental 1 by 1 foot rotary vacuum filter.

Naturally Filtered Water Through Induced Infiltration from Surface Water Bodies, Leland Glidden

This paper deals with the process of abstraction of naturally filtered water through induced infiltration from surface water bodies, such as rivers and lakes. Water thus obtained is relieved of all suspended load, bacteria, and other microorganisms and requires no coagulation or filtration.

Where great capacities of water are needed, raw water is obtained directly from surface water bodies which is subjected to sedimentation, coagulation, and filtration. This method entails a substantial financial burden as it requires a heavy cash outlay and additional expenditures yearly for operation and maintenance. The introduction of the Ranney system of water supply makes possible the extensive use of induced infiltration to a high degree of efficiency, and huge volumes of good wholesome water have been and are being obtained economically.

The paper further describes how this result can be attained through the intermediary of a Ranney collector which is substantially a vertical shaft, sealed at the bottom, with horizontal screen projected radially at the bottom of a water-bearing formation. Where this formation extends up to the ground and is in direct contact with a surface water body,

(*continued on page 54A*)

An Open Letter To Tappimen

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(*continued from page 52A*)

large capacities of clear water are obtainable through induced infiltration.

The process is no longer in experimental stage but has withstood the test of actual application successfully during the war and postwar periods. There are over 80 collectors in the United States, a great majority of which are river or lake infiltration units. The quality of water abstracted from such units is so good that some municipalities are using naturally filtered raw water without further treatment, except a light chlorination, which is required by the various State Boards of Health as a precautionary measure. Such water is always cooler in summer than the water of the surface source from which it actually originates.

A New Printing Ink Drying Test, Everett F. Carman

A new machine known as the Ink Dryograph has been designed to test the drying of printing inks.

The conventional method of testing with the finger by rubbing is unsatisfactory. Two experimental machines have been made by others. The National Printing Ink Institute has built a machine for this purpose but has not done enough experimental work to prove its utility. Another machine has been built in Holland for experimental testing. The Gardner Laboratories have two machines for testing paint which have been tried. Another paint drying tester which has been built by the Reichhold Chemical Company has also been tried.

The "Ink Dryograph" has been designed to test twenty-four prints at one time. It automatically makes a test on each print every 30 minutes for twenty-six hours. The machine consists of two drums four inches in diameter and five inches long, each holding twelve printed strips. The strips are one-half inch wide and are clamped lengthwise in the drum at each end. A sheet of paper which extends around the entire drum covers the wet prints. The drum makes one revolution every 30 minutes. A weighted stylus which presses against the paper on the drum causing the wet ink to leave a series of parallel lines $^{3}/_{32}$ of an inch apart for each test strip until the inks are dry. An attachment has been added for making rub tests and scratch tests on dry printed sheets.

Paper for Web Offset Printing, Milton Zucker

It was not much more than a dozen years ago that rotary web letterpress printing was restricted to single color work at low speeds. In that short space of time, the successful development of paper machine coated paper, heat-drying printing inks, and heaters has moved the process into the field of high-speed four-color printing.

The advantages of offset for certain types of work early suggested the application of the heat-drying technique to web offset; but the process appeared economically unsound for high-speed four-color printing because the best plates available had rather uncertain life, breaking down at from 25,000 to 200,000 impressions depending on the character of the work. Recent commercialization of longer life plates with wear characteristics definitely comparable with letterpress, has now opened the possibilities for the change to four-color high-speed web offset work.

Presses are not a barrier; there are over 160 users of web offset presses. Heat drying inks are available. The problem of damper life is still unsettled, but it is definitely helped by the long life plates; in any event, this problem is not considered critical by most students of the problem. The principal problem is paper which will be comparable in cost and appearance with the paper machine coated letterpress paper, the advent of which, in combination with heat-setting inks, induced the advance of high-grade rotary letterpress.

The IPI research laboratory in New York has been working for the past eighteen months on the problem, in co-operation with a number of papermakers and printers using a four-color rotary web offset press equipped with heaters, and capable of running over 900 feet per minute. In general, no serious problems have been encountered at low press speeds; ordinary letterpress paper machine coated papers give reasonably good results. At competitive speeds, however, accumulation of paper fiber or coating on the press blankets is a major problem, being sufficiently bad in most instances to require wash up after a single 36-inch diameter roll.

An Introduction to Ink Coverage, A. C. Zettlemoyer and Clyde G. Eckhart

The coverage of an ink on a particular paper is the area of paper which can be brought to the desired depth of color or blackness per unit weight of ink. This quantity and the per cent of printed area on the sheet are critical factors in the estimation of ink requirements for any printing job. The coverage obtained with any particular ink is a function of the properties of both the ink and the paper as well as press operation.

In this initial study a technique for measuring ink coverage has been developed. Prints were made with tint block used on a Vandercook No. 4 proof press modified so that the rate of printing is reproducible. A Photovolt Reflection Meter has been used to measure the degree of coverage as the film thickness was varied. Direct weighing was used to determine the film thickness.

Some of the factors involved have been examined in a series of ink and paper combinations as used by a publisher. Wide variations have been found in ink requirements. A systematic study of ink variables has also been started. The effect of pigment loading, viscosity of the vehicle and composition of the vehicle have been investigated.

The Solubility of Sulphur Dioxide in Magnesium Bisulphite Solutions, Frank H. Conrad and Donat B. Brice

The Duhring relation was applied to a 3-phase 3-component system for the determination of the solubility of the combined sulphur dioxide. The experimental data at 15 and 25°C. were extrapolated for 5, 35, 50, and 60°C. and single solubility determinations at 35°C. add greatly to the reliability of the work.

Pressure composition curves are presented in terms of combined and total SO_2 for temperatures ranging from 5 to 60°C.

Comparison with data of other workers for the unsaturated region where but liquid and gas phases are present, indicate that $p - t - z$ diagrams $[p - ps = K\ (\pm\ 1.95z)]$, where p = SO_2 pressure above solution, ps = SO_2 pressure above a saturated solution, t = total SO_2 per 100 g. H_2O, z = g. combined SO_2 as in $MgSO_3$ per 100 g. H_2O, will describe the system $MgO–SO_2–H_2O$ for the range of 5 to 60°C. and total pressure to 1 atmosphere.

Spray Drying Coefficients for Sulphite Waste Liquor, H. H. Folger, F. Herbolzheimer, R. M. Stinchfield, and L. C. Jenness

In the process of obtaining pilot plant quantities of solids from spray dried sulphite waste, liquor data were obtained from which a method of computing an over-all heat transfer coefficient, K, is proposed. It is believed that a relationship between the rate of absorption of heat for the vaporization of water, the volume of the spray chamber, and the temperature driving force of the heating medium should be useful for the design of spray drying equipment and for the correlation of data on spray drying. The relationship proposed is $Q/O = KV\Delta tm$, in which Q is the amount of heat utilized by the vaporization of water in the time O. The volume of the spray chamber, V, is in cubic feet and the logarithmic mean temperature difference, Δtm, is in degree Fahrenheit between the dry bulb and wet bulb temperatures of the heating medium.

Values of the heat transfer coefficient, K, are presented for the spray drying of sulphite waste liquor of 8, 24, and 45% solids in a Bowen laboratory drier, and for 25% solids in a tower drier. Flue gas was used as a heating medium for both units and the temperature of the entering gas varied from 300 to 600°F. The tower drier was supplied with liquor from pressure type nozzles, and the Bowen drier utilized a rotary nozzle. The coefficients for the Bowen unit were 10.1, 6.8, and 4.6, respectively, for feed liquor of solids concentrations of 8, 24, and 45%. The coefficients for the tower unit, when supplied with liquor of 24% solids, were 5.1 for parallel operation and 7.1 for countercurrent operation.

The product from the tower drier was of larger particle size, darker in color, and less hygroscopic than that from the Bowen unit.

It was concluded that the type of atomizer utilized had less effect on the coefficient than did the concentration of solids in the feed liquor.

Continuous Production of Yeast from Sulphite Waste Liquor on a Laboratory Scale, Aaron E. Markham, Hilda D. Agar, and Joseph L. McCarthy

Yeast (*Torulopsis utilis*) has been grown in a continuous laboratory scale tower propagator operated at 30°C. under several sets of conditions to process 4 to 14 liters per hour of steam stripped calcium sulphite waste liquor. Measurements have been recorded relative to the operation of the propagator. Samples of the yeast produced were separated by centrifugation, dried, and analyzed. As a result of yeast growth, the content of reducing substances in the sulphite waste liquor was decreased from about 25 to about 10 g. per liter. The yield of yeast amounted to about 35 to 40% by weight of the reducing substances consumed with the latter being calculated as glucose. The dry yeast contained about 8% N and 6.5% ash. The vitamins, riboflavin, nicotinic acid, and pantothenic acid were found present to the extent of 50, 350, and 70 to 125 micrograms per gram of dry yeast, respectively.

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Slitting and Rewinding
AT LOWER COST
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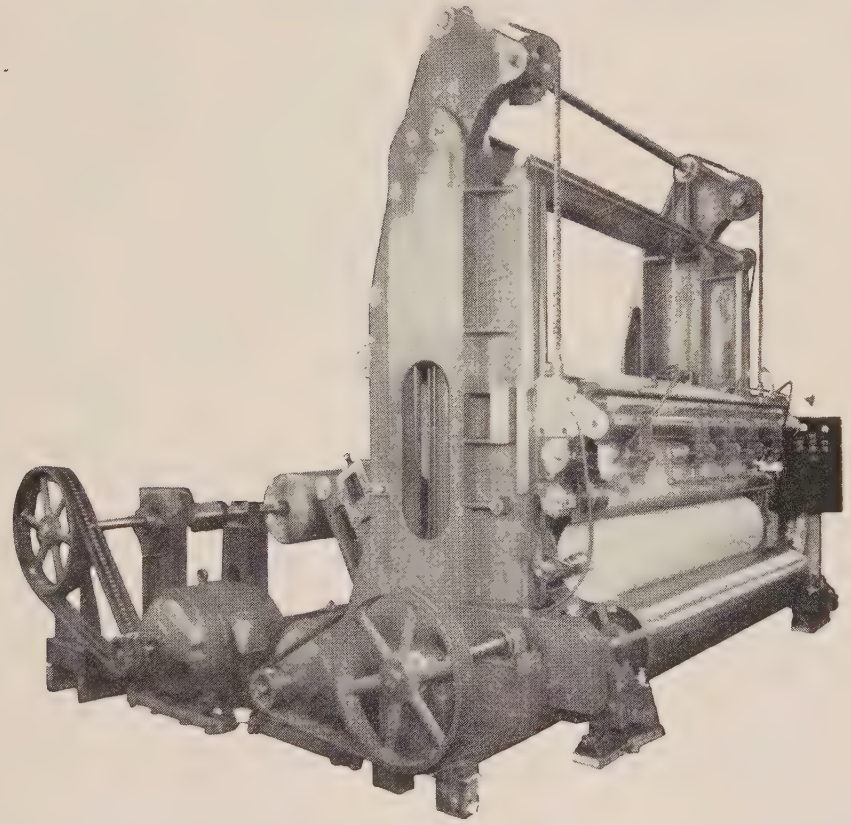

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(*continued from page 54A*)

Deinking Studies. III. Selective Screening and Refining as Applied to Partially Deinked Stock, H. P. Bailey, J. J. Forsythe, and J. F. Tomaszcwski

Experiments previously made in a commercial deinking system have indicated that the major part of the defibering and deinking has been obtained during the initial disintegration in an impeller type centrifugal pulper. Further work conducted on a semicommercial scale has shown that it is possible to take the partially deinked and defibered stock from the centrifugal pulper and by selective screening with Jonsson screens to separate out the deinked and defibered fractions which can then be run directly to brown stock washers, thereby eliminating the normal cooking procedure or making it necessary on a relatively small part of the total stock. It has further been indicated that by a combination of selective screening and of disintegration with a small high-speed refiner the elimination of the cooking process could also be affected. Brown stock thus produced can be bleached in the regular manner without adversely affecting cleanliness or other properties of the deinked stock.

The Influence of Resin Bonds on the Water Immersion Stability of Paper Base Laminates, M. P. Seidel

A series of five phenolic resins was prepared in a 5-gallon kettle. These resins were prepared in an identical way except for the condensation catalyst used in their preparation. These resins were then used to treat kraft paper in a semiautomatic treating machine—the treating specifications of the treated materials were identical. Boards $^1/_{16}$-inch thick were made from these treated sheets and laminated at three different temperatures. Samples cut from these boards were immersed in water for a period of 90 days and the weight, length, and thickness changes accompanying this immersion were studied.

It was found that there was no dependence of the moisture dimensional stability properties on the laminating temperature for well-cured boards. The moisture stability properties of the boards are highly sensitive to the catalyst used in condensing the resin. The viscosity of the resin solution is an important tool in charactering both the speed of cure of the resin and the homogeneity of the treated material.

Specifying Paper Quality for Use in Phenolic Laminates, H. A. Anderson

The last decade has seen marked advances in the development of methods of testing industrial papers by such groups as TAPPI and ASTM, but little progress in the standardization of requirements. Orders on paper mills call for a multiplicity of types of tests and permissible limits from various customers, all of whom may, for example, be converting the paper to a given grade of NEMA or ASTM phenolic laminate. Since the quantity ordered by each laminator is small in relation to paper mill output and his requirements are specialized, the business is likely to be unattractive to the mill and the laminator finds the requisite quality of paper costly and hard to secure.

In an attempt to improve the situation, an ASTM committee has been organized with a membership composed of interested producers and consumers of absorbent papers. The committee has prepared a specification for paper for use in phenolic laminates, which is in the process of being officially adopted following two years of development. It will cover four thicknesses, each, of (1) rag stock, (2) alpha-cellulose, and (3) high and (4) medium absorbency kraft. It includes requirements on essential cleanliness, limits for stock content, acidity, dry and wet tensile strength, oil absorption rate, dielectric strength, etc., with appropriate test methods in all cases. In developing the specification the committee has had the benefit of copies of prior company purchase specifications furnished by most of the large phenol fiber manufacturers of the country, as well as the advice of laminating and paper mill technical staffs and IPC, NBS, and other research groups.

It is hoped that the precedents established in this work will facilitate the preparation of specifications for other types of industrial papers, which will be of mutual benefit to paper processors and paper producing mills.

Paper Properties Which Contribute to Qualities of Plastic Laminates, J. C. Pitzer

Several properties which can be varied in the manufacture of a saturating paper show a marked influence on the quality of the finished laminate. Among these properties are: furnish, slime or shives, apparent density, formation, and strength. Illustrations are given which indicate that such laminate qualities as heat resistance, blistering tendencies, and punching are affected by one or more of the paper properties indicated. Test data are given to indicate that qualities which can be measured quantitatively such as water absorption, bonding strength, and flexural strength are influenced by paper properties especially under certain conditioning procedures.

Mechanism of Water Resistance—The Effect of Beating, William S. Wilson

It has probably been assumed that beating or increased sheet density must of necessity increase the water resistance of a sheet of paper. This is undoubtedly true in the case of waterleaf sheets. However, it is not necessarily true in the case of sized sheets.

No one has ever engine sized a sheet of paper so that it would not give a water penetration test. This proves that there are surfaces in all papers having considerable free energy which can be used to raise water above its original level. On the other hand, all sized sheets contain appreciable amounts of air which it is practically impossible to displace with pure water. This proves that much of the pulp surface in sized sheets is completely hydrophobic. There are thus two completely different types of surfaces involved in any sized sheet.

In two previous papers it was suggested that the equilibrium water pickup, the wet break test, and the water permeability test were scientifically more easily justifiable and practically more informative than many of the tests regarded as standard. The work here reported was to find how these tests were affected by pulp freeness.

It immediately became apparent that the above-mentioned ratio of hydrophylic to hydrophobic surface increased with beating and that probably the increased fibrillation resulted in fibrils too small to furnish the amount of surface, or aluminum bond, necessary to hold the relatively large rosin particle against the turbulence of papermaking.

The data leading up to this conclusion are presented together with the suggestion that perhaps a new test for determining what happens to various pulps on the same beating technique and what different beating techniques do to the same pulp has been developed. There are also possibilities of studying the fundamentals of paper tensile strength.

Mill Trials with Aluminum Chloride as an Alum Substitute, C. C. Porter and William H. Lane

No tests larger than laboratory scale nor any commercial usage of aluminum chloride as a size setting agent has heretofore occurred. The reason for this is that aluminum chloride is about three and one-half times as expensive as ordinary papermakers' alum at equivalent aluminum oxide contents.

However, aluminum chloride is widely used in the chemical and petroleum industries and is potentially available as a byproduct from many operations in the form of a concentrated aqueous solution. If half of the 1945 usage of 69,000,000 pounds were available to papermakers, it would be equivalent to approximately one-third of the alum demand of the southern kraft industry.

At Monsanto Chemical Company's Texas City plant, an aqueous aluminum chloride solution is available as a byproduct, at a concentration of 20 to 30% $AlCl_3$, or 7.6 to 11.4% Al_2O_3. Production is estimated to be 20,000 gallons per month, or enough to supply the demand of the 5-vat, 108-inch cylinder machine at Southland Paper Mills.

Mill trials of $3^1/_2$- and 5-days' duration were made on this machine with the aqueous aluminum chloride as an alum substitute while making a variety of kraft specialties including bleached liners and full unbleached sheets, some of which contained groundwood. No changes in the operation of the machine or differences in the sizing of the sheet occurred. Among the tests run on the sheets were caliper, bursting strength, Penescope penetration with 20% lactic acid, and water absorption. None of these changed appreciably as a result of using aluminum chloride in place of alum. Aluminum chloride consumption was approximately the same as normal alum consumption, based on equal Al_2O_3 contents.

One improvement that was attributed directly to the use of the aluminum chloride was a much better color of the sheet.

Another very important improvement resulting from the use of aluminum chloride in place of alum was a marked increase in the efficiency of the melamine resin used for high abrasion resistance and high wet strength. The same abrasion resistance was obtained with 1% of melamine resin in the presence of aluminum chloride as was ordinarily obtained with $2^1/_2$% of the resin in the presence of alum! This improvement was attributed to the decrease in sulphate ion concentration.

A New Liquid Penetration Test for Measuring the Sizing of Paper, Donna Price, R. H. Osborn, and J. W. Davis

An instrument has been developed for measuring the diffuse reflectance or diffuse transmittance of paper while it is being penetrated by a test liquid. Because wetting by a transparent liquid, e.g., water, oil, or dilute acid, increases the transmittance of paper, measurements of transmittance permits determina-

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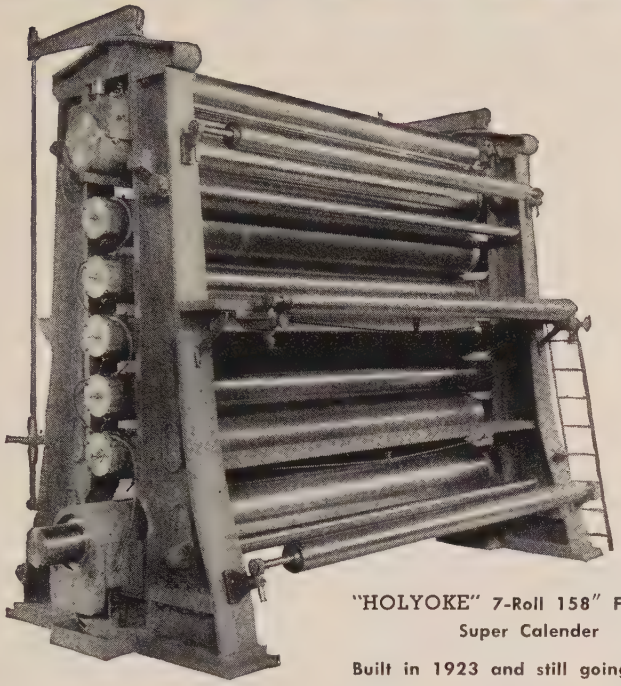

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tions of the rate of penetration and the transudation time for the penetrating liquid. When the penetrating liquid, e.g., ink, is colored, reflectance measurements can be used to obtain the same information.

Rates of penetration and transudation times have been compared with other sizing test values for a number of samples of paper. Data have also been obtained to show the effect of papermaking variables such as basis weight, size concentration, and type of pulp on the rates of penetration by various test liquids.

When the papers being tested have approximately the same thickness and opacity, single-point measurements, e.g., time required for a specified decrease in reflectance or increase in transmittance, can be used to rate papers according to their resistance to the penetration of the test liquids. Single-point measurements are of course more readily obtained than the complete transmittance–time curves which are needed for determining transudation times or penetration rates.

The instrument consists essentially of a light source and an integrating sphere on top of which is mounted a holder for the sample of paper. A beam of radiation from a mercury arc lamp filtered to isolate the 5461 A line or, alternatively, a filtered beam from an incandescent lamp impinges on the sphere wall where it is diffusely reflected. Thus, the underside of the paper sample is diffusely illuminated. A barrier-layer photocell, mounted in the sphere, is diaphragmed in such a way that it views only the underside of the sample sheet. This photocell is balanced against a second photocell which views a filtered beam directly from the lamp. This arrangement minimizes the effect of fluctuation in illumination. A measured amount of ink or other penetrant is poured onto the upper surface of the paper sample, and the rate of change of reflectance of the undersurface is measured.

The rate of change of transmittance, as penetration by a transparent liquid proceeds, may be measured by means of a second integrating sphere placed on top of the first in such a manner that light from the lower sphere transmitted through the paper sample is collected by the upper sphere. The upper sphere contains a third barrier-layer photocell, the connections of which are interchanged with those of the lower sphere photocell when rate of change of transmittance is being measured.

Equipment for Feeding Liquid Slime Control Toxicants into Pulp and Paper Systems, Charles W. Dean

As paper mills have become more aware of the losses caused by slime, the use of chemical toxicants to control these losses has become more widespread. However, the need for careful control of the dosages of these toxicants in order to obtain maximum benefit has not been so well recognized. Nevertheless, it has been demonstrated by numerous mills that maintaining the proper concentration of toxicant for the proper length of time is necessary if a sound slime control program is to be realized. To aid in feeding the desired amount of liquid toxicant into the system, dependable feeding equipment may be installed.

Two basic feeding equipment systems are discussed. In the first a small piston-type positive displacement pump is utilized. To this pump is added a rotameter, either indicating or recording, to give a visual or permanent record of the amount fed. In addition, other equipment such as a cycle controller, proportioning equipment, etc., may be added. This system is satisfactory but its initial cost is high.

A second system utilizes a gear-type positive displacement pump plus a rotameter. These two units cost approximately $100 and provide a reasonably dependable feeding system when used as recommended. The piping arrangement provides for recirculating a portion of the toxicant between the pump and drum. The desired amount is fed into the system through the rotameter by adjusting the bypass valve. Due to the small flow to the system it has been found impossible to use a valve in the main line and get constant feeding due to clogging of the valve by foreign material. The bypass arrangement overcomes this difficulty. It is believed the utilization of either of these feeding systems, plus a consistently maintained inventory control, will help in attaining economical slime control.

Penicillium Roqueforti Thom, a Mold with a High Resistance to Organomercurials, John W. Appling, Stanley J. Buckman, and Robert N. Meals

The only surviving mold in groundwood pulp treated with phenylmercuric acetate was identified as *Penicillium roqueforti* Thom. It is suggested that this mold may be a fairly common one in Scandinavian pulp mills and also that it may be one of the unidentified species of *Penicillium* frequently observed in pulp and slime samples of the United States and Canada. The inhibiting concentration of phenylmercuric acetate in malt agar was about 8 p.p.m. for this mold, a value about four times that obtained for *Aspergillus niger*. For sodium pentachlorophenate in malt agar, the inhibiting concentration was about 40 to 60% less than for *A. niger*. The growth pattern below the inhibiting concentration was normal for the second toxicant but abnormal for phenylmercuric acetate. Chemical analyses of uninoculated controls of groundwood pulp mats with and without added nutrients were compared with those of similar mats which had been subjected during nine weeks to the action of *P. roqueforti*. Changes were of such small magnitude, even in the presence of added nutrients which greatly stimulated growth, that it was concluded they would not measurably affect the usefulness of the pulp.

Evaluation of the Effectiveness of Moldproof Treatment of Paper and Paperboard, G. A. Cruickshank

In the agar plate method of testing the antimycotic properties of paper in the measure of apparent mold resistance depends upon the ratio between the weight of the paper sample and the amount of agar used in the test, upon the pH of the agar, upon the resistance of the test organism, and upon the length of the incubation period. Variation of any of these factors can, in certain cases, completely reverse the interpretation of the test.

A sample of 0.001 glassine, pH 5.35, containing 0.24% sodium pentachlorophenate failed to inhibit growth of the test organism using 15 ml. of agar in the test. However, when using the same amount of agar with six thicknesses of paper, complete inhibition was obtained. With less than six plies the amount of growth varied according to the number of sheets used. Using a single sheet, a similar gradation of growth was obtained by varying the amount of agar. No growth occurred with 5 ml. of agar, whereas growth was present in increasing abundance in tests employing 10, 15, 20, and 25 ml., respectively.

A sample of 0.003 soap wrap tested using 15 ml. agar over a pH range of 5.5 to 8.9 completely inhibited growth of *Aspergillus niger* at pH 5.9 and below. Growth of *A. versicolor* was somewhat retarded but still moderately abundant at pH 5.5. Repetition of the experiment using *A. versicolor* on only 5 ml. of agar showed considerably greater inhibition on the acid side than with 15 ml. of agar. Growth at pH 5.5 was almost entirely absent. These experiments illustrate not only the effect of pH, but also the difference in resistance between two common molds. They further emphasize the importance of the paper-to-agar weight ratio.

The gradual encroachment of mold growth over the edges of the paper, frequently occurring after two or three weeks of incubation, is probably due to diffusion of the antimycotic from the paper. It is suggested that the effect of this diffusion upon the interpretation of the test may be limited by adherence to a constant paper-to-agar weight ratio, thereby permitting more rapid and accurate judgment as to the antimycotic properties of different papers.

Establishing a Nontoxic Germicide, C. H. Rogers

This paper describes the various tests involved in order to establish a chemical germicide as nontoxic. The germicide tested was beta-hydroxyethyl pyridinium-2-benzothiazyl sulphide, first evaluated against TAPPI Standard Method T449 m-45 and the U. S. Milk Ordinance and Code.

A discussion of toxicity stresses the fact that with such a subject everything is relative—a completely nontoxic agent having no technical value where one form of life is combatted to safeguard another. Most materials foreign to a living organism are toxic in some degree. Acute toxicity studies showed the median lethal dose (LD_{50}) to be 2900 mg. per kg. body weight for rats and 1230 mg. per kg. for mice. A relative acute toxicity table compares the LD_{100} values of this chemical to other well-known chemical agents from Ricin at 0.003 mg. per kg. to this germicide at 3700 mg. per kg.

Chronic toxicity studies showed the effect of prolonged daily consumption of large quantities of germicide (25 and 50 times practical maximum amount used in manufacture of paper) by rats. At end of 12-week test, animals on diet with germicide show weight gained per 100 g. food consumed equal to that of control rats. Blood hemoglobin tests on each animal show no significant differences between tests and controls. Conclusion is that the germicide would be safe to use in paper food containers.

Dermatitis and sensitization tests on human subjects were all negative, indicating the germicide is safe for personnel to handle. On the results of all tests described it is believed the germicide has been established as a nontoxic agent.

Principles Governing the Choice Between Electrical and Nonelectrical Instruments, David H. Fuller

The application of electrical instruments in many instances parallels the application of mechanical instruments. Two criteria for determining which type to use are over-all economy and achievement of results with one type which are impossible with the other.

(*continued on page 60A*)

Birthplace of a Great Idea

In the 1860's John Huyck and his son, Francis Conkling Huyck, conducted a general store in Rensselaerville, New York. Here young Huyck found that successful storekeeping was firmly based on good service to the customer. He had imagination and initiative and he was eager to apply his talents to a more challenging enterprise. Soon the opportunity came. America's paper mills were beginning to boom, but papermakers' felts were imported from Europe. Why not make these felts right in Rensselaerville? John Huyck appraised the opportunity and encouraged his son to go ahead. So in 1870 Francis Conkling Huyck, with an associate, opened a felt mill and commenced the manufacture of papermakers' felts. That venture grew to become the firm of F. C. Huyck & Sons. Today this company strives to perpetuate the policy established by its founder—good service to the great American paper industry.

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(*continued from page 58A*)

Over-all economy is determined by obvious factors—first cost, cost of installation, maintenance, service, and repair. Where single-point measurement is concerned and the instrument is located adjacent to point of measurement, mechanical instruments are generally preferred. If the distance between point of measurement and instrument location is great, electrical instruments generally have lower over-all cost unless explosion hazards exist or power is not readily available. If conditions of installation are such that damage is likely to occur to connecting tubing or cable of a temperature instrument, the electrical instrument will make up the difference in initial cost wthin one or two repair jobs. If a number of different points of measurement may be combined upon one indicator or recorder, the electrical instrument is usually to be preferred over several individual or even combined mechanical instruments. Less obvious but equally important relative factors are production quality and quantity, instrument down time, flexibility, and adaptability to installation conditions.

Electrical instruments afford centralized control with improved production. On continuous processes, decreased down time to service electrical instruments is more important than on batch processes. Flexibility of electrical instruments is important on changing processes. Single-purpose instruments may have lower first cost. Mechanical or electronic instruments withstand vibration well but electrical instruments do not.

Achievement of previously impossible results usually comes from the measurement of a new variable. Examples are quality control by boiling point rise method, conductivity measurement, roll surface temperature measurement, motor load measurement for stock dilution control, gloss, tension, force, weight measurement, etc. The future holds additional promise of more electric control.

Instruments and Controls—Factors in Their Selection, Harold A. Sholl

Paper mill instrumentation has progressed from the experimental stage to a condition of certainty for most applications. However, standardized procedures cannot be prescribed for the majority of instrument control uses because few processes are identical.

Instrument and control selection can be based on experience gained by mill men and instrument engineers from similar installations, but this serves only as a starting point. Factors paramount to one application may be relatively unimportant or completely absent from another so that previous application experience must be backed up by a thorough engineering study of the problem at hand. Determination of all variables and required results may indicate the need for elaborate cascade control, in one case, or in other cases, a simple inexpensive controller. The complete analysis of each control application makes possible accurate prediction of process results to be expected from the expenditure for instrumentation, thus more confidently justifying such expenditures to management.

Automatic Start-up of Process with Reset Controllers, H. R. Bristol

An analysis of the difficulties involved in starting a process on reset control. A suggested method of pre-shifting the proportional band so that automatic start-up of a process becomes a safe, fast, and simple procedure. This method eliminates the need for continuous operator supervision of the process start-up.

The Possible Correlation Between Hemicelluloses and the Physical Properties of Bleached Kraft Pulps, Francis T. Ratliff

Five graded pine kraft pulps (ranging in yield from 43 to 66.4%) were bleached with acidified sodium chlorite, thus giving yields ranging from 41.9 to 50.5% (all yields were determined on the unscreened basis). Physical evaluation and chemical analysis of the bleached pulps showed that in general, strength properties increased continuously with yield and, also, with the hemicellulose content. Handsheets made from the bleached pulps indicated that the area in optical contact was closely related to other pulp properties. Thus, the area of optical contact appears to be a reasonably direct function of the actual bonded area, and the latter (particularly in the early stages of beating) is correlated with the bursting and tensile strengths of the sheet. Apparently the hemicelluloses manifest their effects upon pulp properties by enabling a high specific surface and bonded area to be developed during beating without much decrease in fiber strength. There appears to be some correlation between the hemicellulose content and the physical properties of the bleached pulps, but these relationships are less regular than are those between pulp yield and physical properties. Analyses show that, even in a very raw cook, an appreciable amount of the alpha-cellulose originally present in the wood is destroyed or degraded, and that potentially important carbohydrate material is lost even under very mild kraft cooking conditions.

Commercial Variance in Schopper Folding Tests, H. S. Spencer

The object of making these tests at eight different laboratories was to allow each to check its instruments with others of the same type. The paper was selected by a skilled chemist, well versed in testing procedure. All doubtful sheets were discarded.

Eight groups of samples from Howard Smith Paper Mills, Beauharnois, were divided into lots of twenty-five sheets each; these were sent to eight different companies, or laboratories, who had agreed to making the tests at 50% relative humidity and 70°F., according to TAPPI standard method T423 m-45. This method calls for folding endurance to be reported as the average of "at least ten specimens cut from each principal direction." All of the laboratories exceeded considerably the minimum of ten tests.

The comments are made for the layman and not the skilled tester of paper. They are nontechnical and we hope will be of use to purchasing agents and users of paper as well as operators who have standards to meet. These groups have a right to know the accuracy within which a Schopper fold test can be expected to operate under the most ideal conditions.

The summary shows that this paper tested at different laboratories gave widely varying results. Similarly, tests from each laboratory show variations over a wide range. If these conditions occur, with all precautions for good testing methods having been taken, it can be expected that spot checks on paper made by people not skilled in the use of the Schopper fold tester or testing methods will result in much less accurate figures. It would seem that specifications based on an accuracy of 10 to 20% are too rigid and unfair. Indications are that comparisons made on one tester are more valuable than comparisons between testers.

The Measurement of Water-Vapor Permeability at Low Temperatures by Means of the Hygrometric Sweep-Gas Method, Leonard R. Dearth and W. A. Wink

Because of the difficulties in the measurement of water-vapor permeability of vapor-resistant barriers at low temperatures by means of the gravimetric method, new equipment, based on the hygrometric sweep-gas method, has been developed, and is described. The new method has been made possible by the recent development of very small, sensitive, and stable electric hygrometers. The sensitivity of the new method results from a combination of the inherent sensitivity of the hygrometric principle and the ability of the small electric hygrometer accurately to measure small changes in the relative humidity of the air passing over a specimen. The sweep-gas method is of the steady-state class and is free of error at equilibrium arising in sorption effects. The sensitivity of the new method is sufficiently high that the length of time required to complete a test is limited only by the nature of the material, especially as the latter determines the time required for the specimen to attain equilibrium with the relative humidities of the air in contact with its two sides. The operation of the new equipment is illustrated by the performance on several samples of different types.

A Note on the Coefficients of the Kubelka-Munk Theory of the Scattering and Absorption of Light in Paper and Other Diffusing Media, J. A. Van den Akker

The majority of the optical properties of paper depend for their evaluation on diffuse reflectance which, in turn, is related through the Kubelka-Munk theory to the scattering and absorption coefficients of the paper. The latter have often been employed in studies of the optical properties of paper and other light-scattering media. In the development of their useful theory, Kubelka and Munk have followed the convention of employing distance (x) as the independent variable. In the application of the Kubelka-Munk theory, thickness (X) has not proved to be a convenient quantity; for example, it has usually been found to be expedient to substitute basis weight for X. The awkwardness of X in the theory is illustrated in (1) the apparent change in S and K when density is changed in such manner that the scattering power and absorbing power of a sheet actually do not change, (2) the difficulty of relating formulas, based on weights of the components, with X, and (3) the difficulty of relating the absorption coefficient of coloring matter in solution with the contribution of such coloring matter to the calculated absorption coefficient of pulp or paper. It is shown that the differential equation on which the Kubelka-Munk theory is based can be replaced with one that is mathematically equivalent, but in which S and K are replaced with, respectively, the specific

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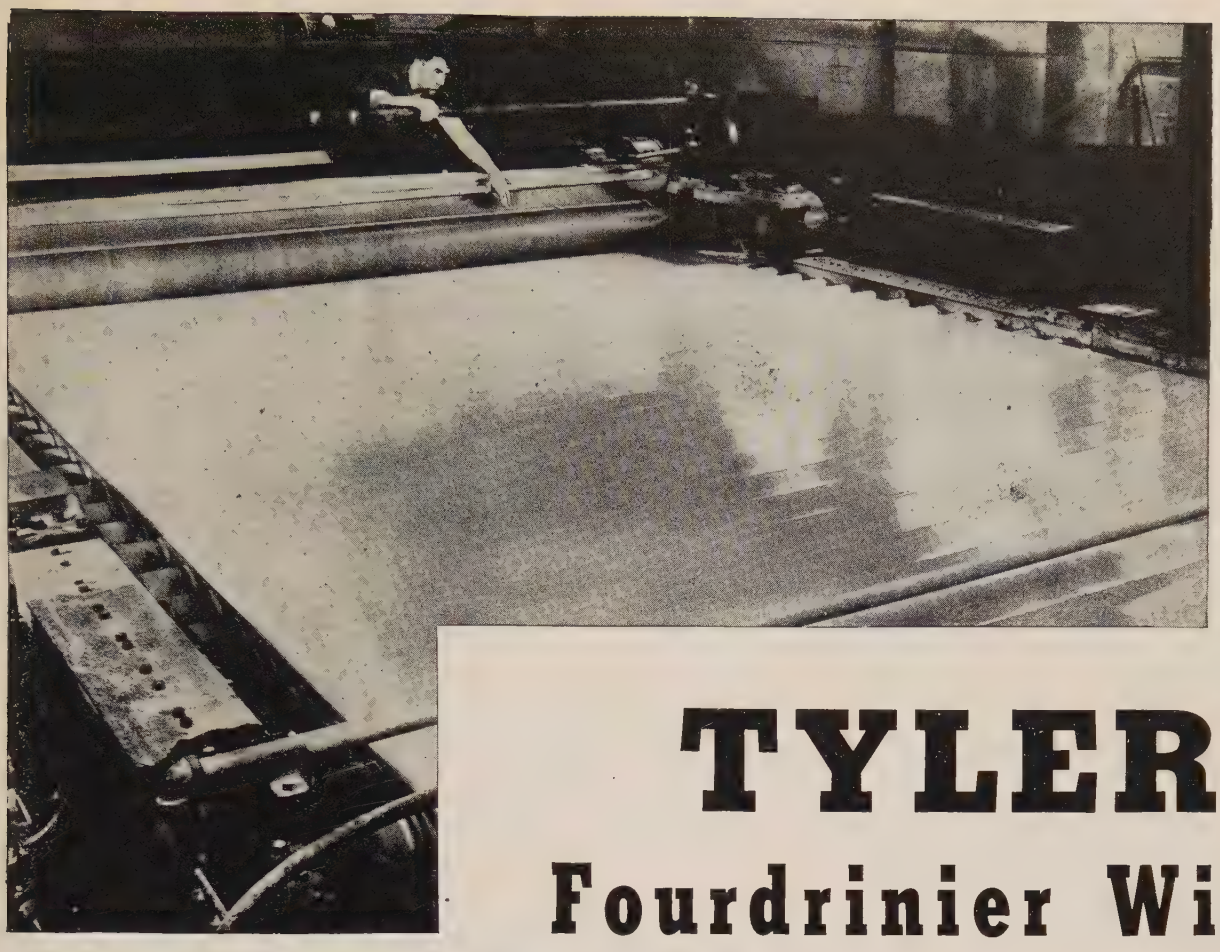

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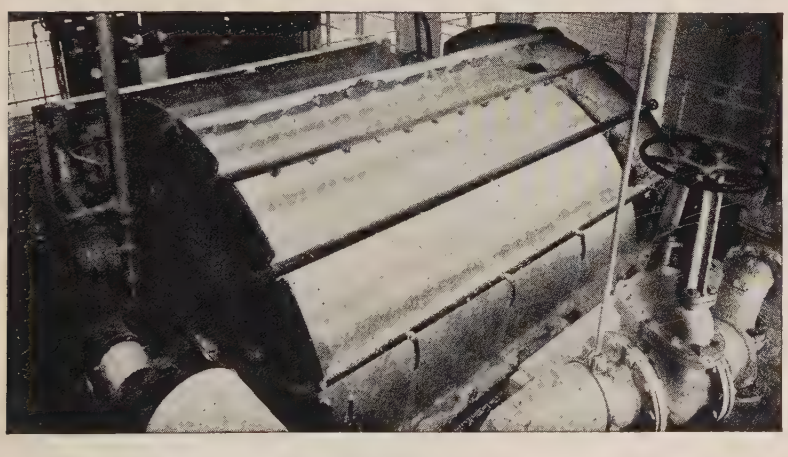

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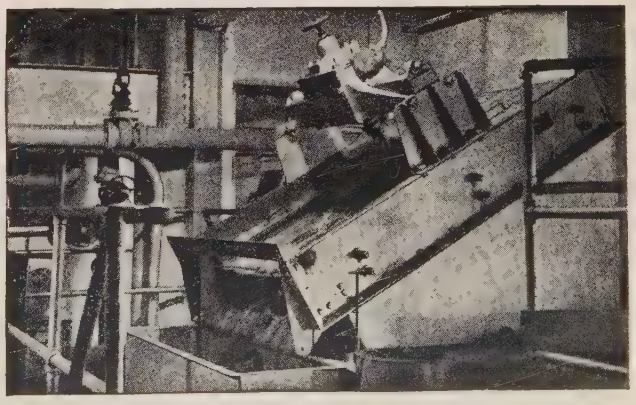

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(*continued from page 60A*)

scattering coefficient (s) and the specific absorption coefficient (k) and in which an infinitesimal increment in distance (dx) is replaced by an infinitesimal increment in weight per unit area (basis weight) (dW). All the relationships of the Kubelka-Munk theory, all tabulations, and all charts remain the same except that W everywhere replaces X, s replaces S, k replaces K, and, in particular, sW replaces SX. It is suggested that new compilations of the theory and new issues of charts be modified in accordance with these simple changes. The advantages of the change in point of view are discussed with illustrative cases.

A New Mechano-Chemical Process for Pulping Agricultural Residues. Preliminary Report, S. I. Aronovsky and E. C. Lathrop

A new process has been developed for pulping agricultural residues involving combined and simultaneous chemical and mechanical action on the raw material at atmospheric pressure and at temperatures at or near 100°C. Excellent strawboard pulps were produced by cooking wheat straw for 1 hour in a laboratory hydrapulper using the normal amounts of chemicals. Strong, easy-bleaching kraft straw pulps were made in a half-hour cooking period in this equipment. Re-use of the kraft black liquor from the hydrapulper for three successive subsequent cooks had no appreciable effect on the yields or properties of the resulting pulps. The final black liquor contained more than 7% of organic matter. A possible explanation for the rapid pulping action in the hydrapulper is given. The significance of these preliminary results and the advantages of this method of pulping are discussed. This mechano-chemical process might have considerable influence in increasing the use of agricultural residues for paper, board, and their products.

Evaluation of Fibrous Agricultural Residues for Structural Building Board Products. III. A Process for the Manufacture of High-Grade Products from Wheat Straw, E. C. Lathrop and T. R. Naffziger

The details of a process for the manufacture of high-quality, very rugged insulating building board from wheat straw are presented. Two kinds of pulp are required: (1) unhydrated long fibered pulp, and (2) hydrated pulp equivalent to that used in strawboard manufacture. Two methods are described for the preparation of these: by pressure cooking or by a new very rapid method of atmospheric cooking and disk refining. The effect of operating variables on physical properties, such as straw varieties, cooking and refining, per cent hydrated fiber and per cent long fiber in pulp blends, per cent moisture of board into drier, have been carefully studied. Based on previous fundamental work it is possible to arrange this information in the form of an accurate operating range of pulp blends as related to properties of finished product. Due to the springy straw fibers the board may be dried at 50–55% moisture content with large savings in drying costs. Dense boards may be made by drying in the hydraulic press. Process equipment and economics are discussed.

Some Fundamental Aspects of Bonding Between Fibers, H. Mork

The bonding between fibers is of importance for the mechanical behavior of textiles, felts, leather, and paper. There seem to be several types of bonds which contribute to the total effect. The weakest bond is that by merely mechanical action of rugged surfaces; it is responsible for the surface friction of fibers against each other which is used in the construction of yarns and fabrics. Next comes the attraction of polar groups with or without the action of an intermediate layer of polarized liquid. The strongest links which seem to play a role in fiber-to-fiber bonding are hydrogen bridges, which can develop between strong dipoles on one hand and hydrogen-containing groups on the other.

Some Factors in the Strength of Paper, W. Gallay

The structure and physical properties of pulp fibers are discussed with special reference to a comparison of cellulose with a general range of long-chain polymers showing a close integration in this general field. The probability of pre-existence of fibrils and other fine structures in the fiber is examined, and an alternative interpretation of these bodies is offered.

The meaning of limited swelling in linear macromolecules in general and in cellulose fibers in particular, is discussed, and the importance of the degree of swelling of a pulp fiber is emphasized. True adsorption is sharply differentiated from general imbibition, kinetically and thermodynamically.

The possible effects of varying degrees of colloidal swelling on the beating process and on the strength of paper are discussed. The general relationships between colloidal structure of the fiber and mechanism of bonding between fibers are examined. Requirements in suitable extraneous bonding materials or adhesives for pulp fibers are discussed, from the colloid point of view, with typical examples.

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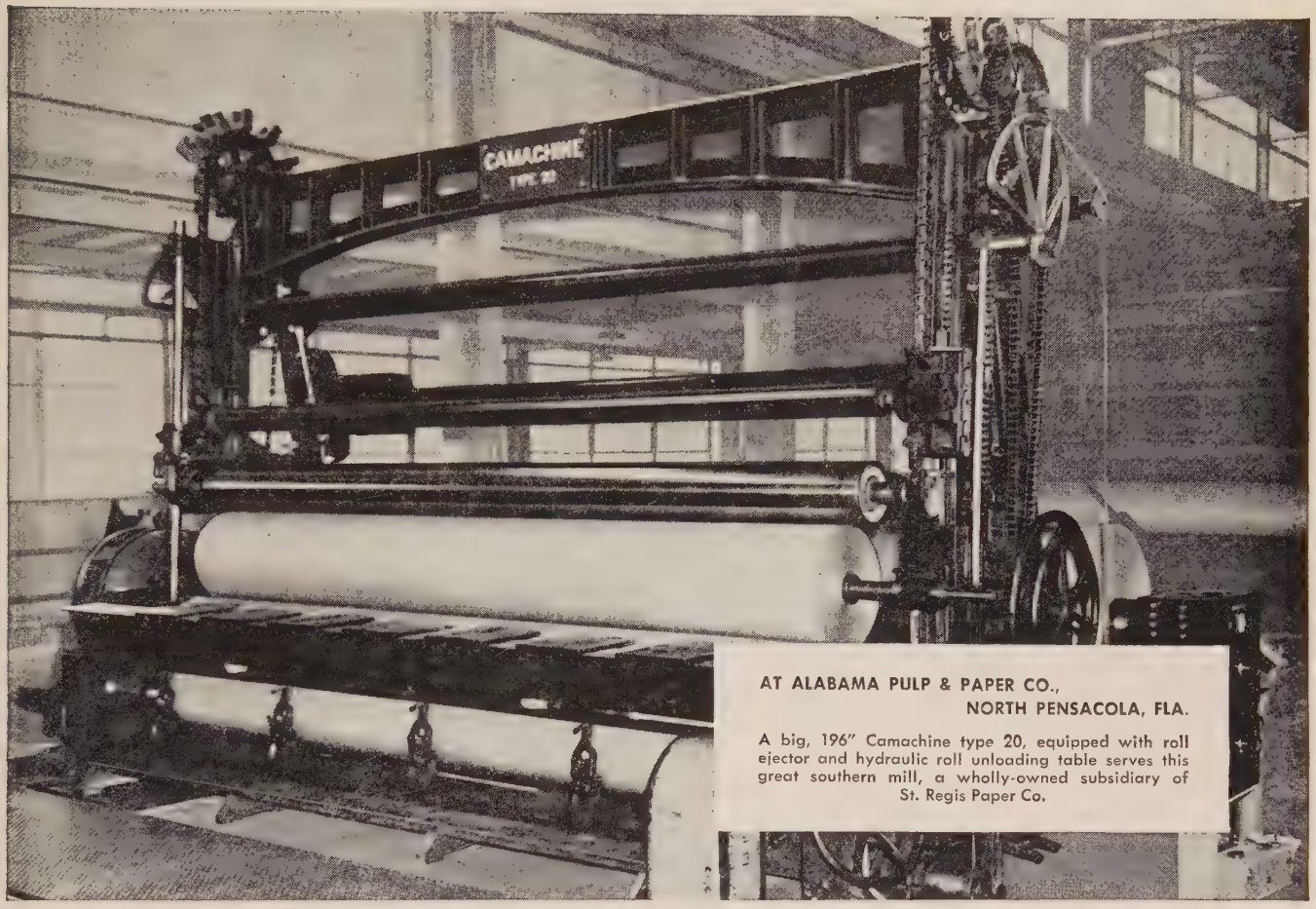

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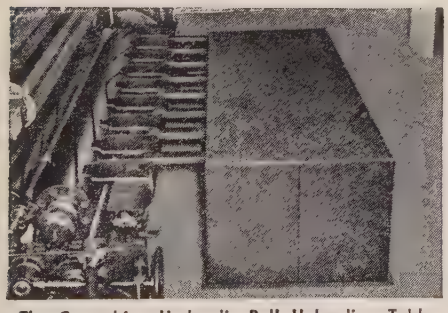
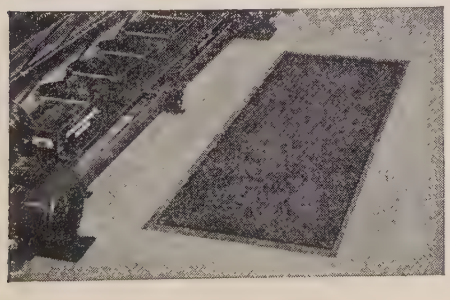
A big, 196" Camachine type 20, equipped with roll ejector and hydraulic roll unloading table serves this great southern mill, a wholly-owned subsidiary of St. Regis Paper Co.



The Camachine Hydraulic Roll Unloading Table, operated by pushbutton control is raised to receive the finished roll from the winder . . . and (below) lowered, stop-and-hold — at any point down to floor level.



The Camachine Hydraulic Roll Unloading Table is only one of many post-war developments which have been made available on famous mill-type Camachines.

Other exclusive Camachine developments which you can't afford to overlook are: the pneumatic brake on drive and idler roll; push-button controlled, motor-driven riding-roll lift and roll ejector; and pneumatically controlled pressure on the cutter wheels and cutter spacer bar.

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AA-182

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Stanley C. Adams, Technical Director, Fernstrom Paper Mills, Inc., Pomona, Calif., a 1939 graduate of Pomona College.

E. Webster Bartholow, Jr., Chemist, Riegel Paper Corp., Milford, N. J., a 1948 graduate of Cornell University.

Lyman A. Beeman, Vice-President, Finch, Pruyn & Co., Inc., Glens Falls, N. Y., a 1918 graduate of the University of Wisconsin.

Kenneth G. Booth, Senior Research Chemist, Central Technical Dept., Crown-Zellerbach Corp., Camas, Wash., a 1940 graduate of the University of British Columbia with a Ph.D. degree from McGill University in 1948.

Burton F. Bowman, Director, Pillsbury Mills, Inc., Minneapolis, Minn., a 1929 graduate of the University of Iowa, with a J.D. degree in 1932.

Allen C. Buck, Group Leader, E. I. du Pont de Nemours & Co., Inc., Parlin, N. J., a 1946 graduate of Western Reserve University with a Ph.D. degree.

Ruel F. Burns, Vice-President and Production Manager, The Terre Haute Paper Co., Terre Haute, Ind., a 1915 graduate of Rose Polytechnic Institute.

Ralph E. Carter, Manager, Paper Products Div., Reichhold Chemicals, Inc., Detroit, Mich., a 1938 graduate of Hillsdale College.

Marius Comps, Technical Manager, Societe CENPA, Paris, France, a 1914 graduate of the University of Toulouse.

Charles P. Craig, Water Supervisor, Riegel Paper Corp., Milford, N. J., a 1948 graduate of Rutgers University.

Raimbault de Montigny, Technical Director, Rolland Paper Co. Ltd., St. Jerome, P. A., Canada, a 1931 graduate of McGill University with a Ph.D. degree in 1934.

James J. Eberl, Director of Chemical Research, Scott Paper Co., Chester, Pa., a 1938 graduate of the University of Buffalo with a Ph.D. degree in 1941.

Adrian J. Ernst, Paper Technologist, Northern Regional Research Laboratory, U. S. Dept. of Agriculture, Peoria, Ill., a 1935 graduate of Carleton College.

Jefferson Farmer, Plant Engineer, Hollingsworth & Whitney Co., Waterville, Me., a 1935 graduate of Massachusetts Institute of Technology.

Nat M. Frisch, Manager, Paper Laboratory, Stein, Hall & Co., New York, N. Y., a 1937 graduate of Georgia School of Technology.

Grant L. Geisinger, Chief Engineer, Northwest Filter Co., Seattle, Wash.

Vincent D. Gerbereux, Assistant Manager, Centrifugal Pump Div., Worthington Pump & Machinery Corp., Harrison, N. J., a 1924 graduate of Cornell University.

Donald S. Goslyne, Chief Chemist, Pittsburgh Steel Co., Monessen, Pa., a 1913 graduate of Princeton University.

J. Thomas Haigh, Technical Director, Pillsbury Mills, Inc., Minneapolis, Minn., a 1939 graduate of the University of North Dakota with an M.S. degree in 1941.

William J. Hall, Student, New York State College of Forestry, Syracuse, N. Y.

Clarence S. V. Hawkings, General Superintendent, Price Brothers & Co. Ltd., Quebec, P. Q., Canada, a 1915 graduate of McMaster University.

Russell F. Hazelton, Associate Professor, Dept. of Chemical Engineering, North Carolina State College, Raleigh, N. C., a 1935 graduate of Wayne University, with an M.S. degree from the University of Michigan in 1937 and a Ph.D. degree in 1943.

Antonius N. J. Heyn, Professor of Natural and Synthetic Fibers, Clemson College, Clemson, S. C., a 1931 graduate of Utrecht University with a Ph.D. degree.

Frank E. Hill, Student, New York State College of Forestry, Syracuse, N. Y.

Richard L. Hoff, Chemist, Riegel Paper Corp., Milford, N. J., a 1946 graduate of Purdue University.

William A. Hoffman, Research Supervisor, E. I. du Pont de Nemours & Co., Inc., Buffalo, N. Y., a 1939 graduate of Northwestern University with a Ph.D. degree.

Walter W. Holland, General Superintendent, Quebec North Shore Paper Co., Baie Comeau, P. Q., Canada.

John C. House, Resident Engineer, West Virginia Pulp & Paper Co., Covington, Va. Attended U. S. Naval Academy.

Robert E. Ingison, Student, New York State College of Forestry, Syracuse, N. Y.

J. Saxon Jones, Research Manager, Samuel Jones & Co. Ltd., Peckham Grove, London, England.

David X. Klein, Manager of Research, Heyden Chemical Corp., Garfield, N. J., a 1930 graduate of the University of Chicago.

Ralph J. Knoll, Technical Director, Scott Paper Co., Chester, Pa., a 1925 graduate of Pennsylvania State College.

Howard V. Lauer, Sr., Industrial Engineer, The National Cash Register Co., Dayton, Ohio, a 1942 graduate of the University of Cincinnati.

George A. Ledingham, Director, Prairie Regional Laboratory, Saskatoon, Sask., Canada, a 1928 graduate of the University of Saskatchewan with an M.Sc. degree, and a Ph.D. degree from the University of Toronto in 1932.

Elisha B. Lewis, Research Chemist, Howard Paper Mills, Inc., Aetna Div., Dayton, Ohio, a 1934 graduate of The Citadel, with an M.S. degree from the University of South Carolina in 1935.

Robert W. Lewis, Student, New York State College of Forestry, Syracuse, N. Y.

Russell L. Lewis, Quality Control Supervisor, St. Regis Paper Co., Deferiet, N. Y., a 1941 graduate of New York State College of Forestry.

Donald W. Light, Director of Research, Ludlow Mfg. & Sales Co., Ludlow, Mass., a 1932 graduate of Harvard University.

Malcolm B. Lowe, Jr., Machine-Tender, Lowe Paper Co., Ridgefield, N. J., a 1947 graduate of Princeton University.

Lennart A. Lundberg, Pulp Div., Weyerhaeuser Timber Co., Longview, Wash., a 1948 graduate of the University of Washington with an M.S. degree.

John S. Markley, Service Metallurgist, Carnegie-Illinois Steel Corp., Chicago, Ill., a 1940 graduate of Missouri School of Mines.

Harold O. McInerney, General Superintendent, Price Brothers & Co. Ltd., Kenogami, P. Q., Canada, a 1920 graduate of the University of New Brunswick.

Lorne B. Mulloy, Chief Engineer, The Haloid Co., Rochester, N. Y., a 1922 graduate of Clarkson College of Technology.

William R. McKelvy, Engineer, Ashuelot Paper Co., Hinsdale, N. H., a 1939 graduate of Yale University.

John W. Padgett, Chemical Engineer, Moore & Munger,

(*continued on page 66A*)

VORTRAPS

What is the most widely used paper stock cleaning apparatus in the world?

LET'S LOOK AT THE RECORD

1——Over **3300** Vortraps in use in the United States.

2——Over **5900** Vortraps in world wide use.

3——Over **250** individual Paper Mills in the United States are users of Vortraps.

4——One large paper company is using over **400** units. Many more have in operation more than **50** Vortraps per plant.

THE PROOF OF THE PUDDING IS IN THE EATING

1948 sales in the United States include **14** new paper companies as Vortrap users with **58** repeat orders for Vortraps from satisfied users.

Vortraps have advantages of applications to ANY and ALL stock cleaning problems. The many sizes and special features of installation and control make this equipment outstanding for all Paper, Paper Board and Pulp applications.

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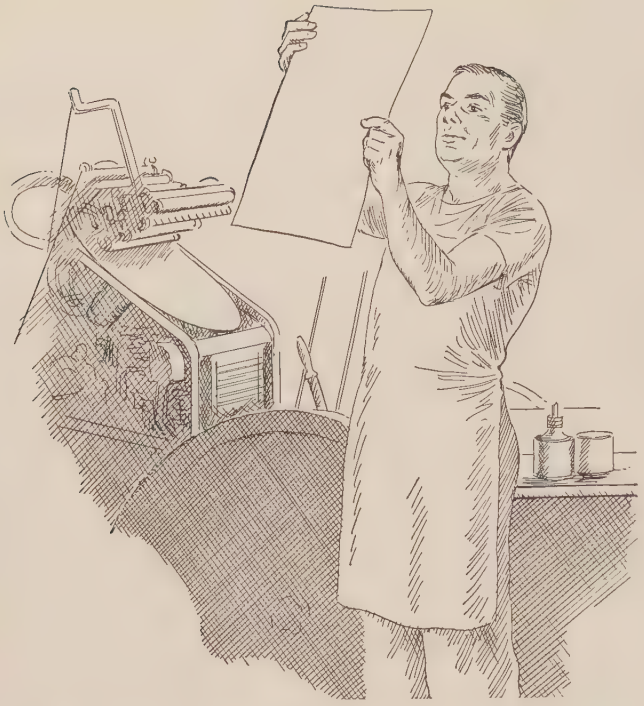


"What've Calender Rolls got to do with me?"

"I'm only a printer. Calender rolls are not in my line! What has the finish to do with me?"

A great deal, Mr. Printer. Finer calendering with Butterworth Calender Rolls produces better finishes and better paper for printing jobs.

Butterworth Rolls are made of the finest materials available, long staple cotton free of any foreign matter and top quality paper of high rag content.

Put a Butterworth roll in a stack with any other roll. Check its performance. You'll see the difference in longer service, in less labor time spent in making changes. Butterworth Rolls are locked on the shaft under tremendous pressure. Can't slip or come loose. Pretested for smoothness, hardness and density.

Whether you do plain calendering, heavy duty friction work, schreiner, embossing or chasing work, Butterworth Calender Rolls will give you many additional hours of top flight service. Call us on your calendering problems. We make Calender Rolls in every size for all types of calendering, or we can refill your present rolls.

For full information, write or call H. W. Butterworth & Sons Company, Philadelphia 25, Penna. — Providence Division, Providence, R. I. : : Charlotte, N. C., 1211 Johnston Building In Canada—W. J. Westaway Company, Hamilton, Ontario

Butterworth Calender Rolls

New York, N. Y., a 1942 graduate of New York University.

Robert H. Pete, Chemist, E. I. du Pont de Nemours & Co., Inc., Niagara Falls, N. Y., a 1939 graduate of Michigan State College.

Charles C. Phelps, Graduate Student, New York State College of Forestry, Syracuse, N. Y., a 1938 graduate of Clarkson College of Technology.

Eleanor L. Regan, Librarian, American Can Co., Maywood, Ill., a 1938 graduate of Beloit College.

William A. Rolke, Chemical Engineer, Research Div., American Can Co., Maywood, Ill., a 1948 graduate of Case Institute of Technology.

Allen T. Roudebush, Junior Research Engineer, Champion Paper & Fibre Co., Hamilton, Ohio, a 1938 graduate of Miami University.

Carleton E. Saecker, Supervisor of Engineering on Felt and Roofing, Barrett Div., Allied Chemical & Dye Corp., New York, N. Y., a 1917 graduate of the University of Wisconsin.

Robertson P. Scott, Plant Engineer, Ball Brothers Co., Noblesville, Ind., a 1926 graduate of Vanderbilt University.

Harold A. Sothern, Representative of Foreign Principals, New York, N. Y.

Wesley R. Thompson, Technical Director, Catalin Corp., Fords, N. J., a 1926 graduate of Brown University.

William E. Welliver, Jr., Pigment Chemist, New York & Pennsylvania Co., Inc., Lock Haven, Pa., a 1938 graduate of Pennsylvania State College, with an M.S. degree from the University of Illinois in 1940.

Harold F. Wood, Jr., Sales Engineer, Heppenstall Co., Pittsburgh, Pa., a 1942 graduate of the University of Michigan.

TAPPI Directory Changes

J. C. Aggarwala is now chief chemist, Shree Gopal Paper Mills, Ltd., Abdullapur, E. Punjab, India.

Carl E. Ahlm, formerly with the Sorg Paper Co., is now with the Chillicothe Paper Co., Chillicothe, Ohio.

Adolph Bednarz, formerly of the Fort Orange Paper Co., is now chemist, Interstate Folding Box Co., Miamisburg, Ohio.

John Cochran, technical service engineer, PMC Dept., Hercules Powder Co., has been transferred from Freeman, Ont., to Holyoke, Mass.

Lawrence C. Crowder, formerly of the Calcasieu Paper Co., is now plant engineer, Macon Kraft Co., Macon, Ga.

B. Walter Crutchfield, formerly of Cia. Rayonera Cubana, is now production manager, Beaunit Mills, Inc., Childersburg, Ala.

John H. Doherty, chemical engineer, Union Bag & Paper Corp., has been transferred from Savannah, Ga., to New York City.

Axel Ekwall, formerly technical adviser to the Swedish Embassy, is now mill manager, Fiskeby Fabriks A/B., Skaerblacka, Sweden.

George A. Farrah, formerly of the Container Laboratories, Inc., is now technical director, National Container Corp., Long Island City, N. Y.

Rowland A. Gale, formerly of Wallerstein Co., is now eastern representative, technical sales, Pillsbury Mills, Inc., 21 West Street, New York, N. Y.

Michael J. Goloff, formerly of Kalamazoo Vegetable Parchment Co., is now chief engineer, St. Regis Paper Co., Kalamazoo, Mich.

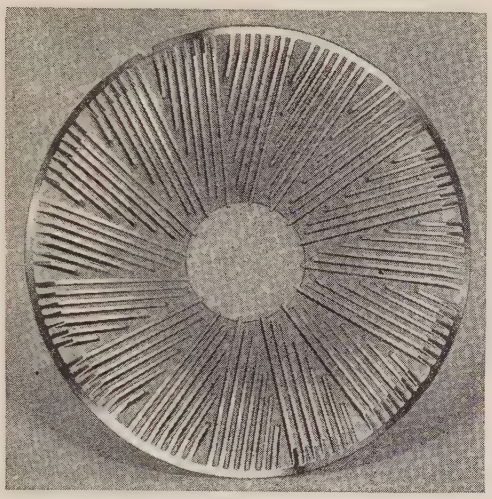
William E. Hamilton, technical service engineer, PMC Dept., Hercules Powder Co., has been transferred from Holyoke, Mass., to Atlanta, Ga.

Sven Hanson, formerly technical manager, A. Ahlstrom O/Y, is now with Aug. Eklof A/B, Borga, Finland.

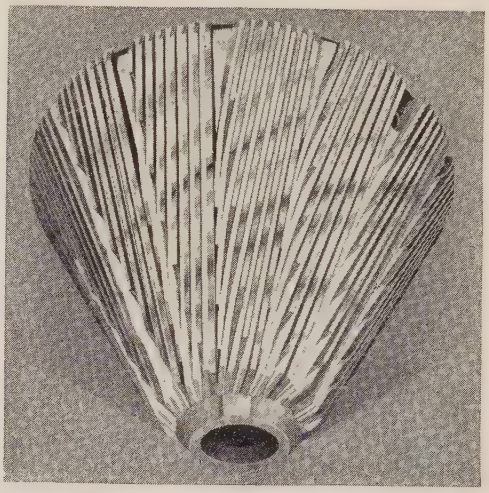
Ward D. Harrison is now manager of production, Riegel Paper Corp., New York, N. Y.

THE HERMANN CLAFLIN REFINER

"WITH"



3/8″ — 1/2″ Cast Steel Shell Liners



3/8″ — 1/2″ Cast Steel Plug Liners

"FOR"

CONTINUOUS STOCK PREPARATION

Application: To brush out fibre bundles and lumps with a minimum of cutting and increase in slowness. Especially desirable for filler and chip furnish of mixed paper and corrugated with Claflin installed between the pulping operation and jordans. Reduces number of jordans required and produces a smoother and stronger stock with power saving.

Installations: Board mills on liner, filler and chipboard; Tissue grades (pulp and deinked stock); Straw; Chestnut; Cornstalks; Bagasse; Semi-chemical; Insulation and building board; Knots and screenings.

THE HERMANN MANUFACTURING CO.

Also: TAPPI Standard Pulp Testing-Sheet Making Apparatus

LANCASTER, OHIO

(*Continued from page 66A*)

Edward L. Hill, formerly chemist, Imperial Institute, is now with the Minister of Supply, London, W.C. 2, England.

Edward J. Jones, formerly of the Institute of Paper Chemistry, is now research supervisor, Celotex Corp., Chicago, Ill.

J. K. Kirkpatrick is now groundwood mill supervisor, Champion Paper & Fibre Co., Pasadena, Tex.

E. L. Kischel, technical director, Alpha Cellulose Corp., has been transferred from Chicago, Ill., to Bloomington, Ind.

George D. Knight, formerly of the Grasselli Dept., E. I. du Pont de Nemours, Inc., is now chemist, C. H. Dexter & Sons, Inc., Windsor Locks, Conn.

R. H. Laftman is now located at 1846 Margaret St., Jacksonville 4, Fla. He continues as a director and vice-president of the National Container Corp.

John D. Lohnas, formerly of the St. Regis Paper Co., is now chemist, Monadnock Paper Mills, Inc., Bennington, N. H.

Colin C. MacDonnell, formerly of St. Raymond Paper Ltd., is now sulphite superintendent, Industrias Klabin do Parana, Sao Paulo, Brazil.

Frank Makara, patent attorney, is now located at 102 W. 80th Street, New York 24, N. Y. Dr. Makara is conducting a course in patent law at New York University.

John C. Meiler, formerly director, Plywood Research Foundation, Tacoma, Wash., is now with the Coos Bay Lumber Co., Coos Bay, Ore.

Ollie W. Messner, formerly of the Lowe Paper Co., is now production manager, Tarentum Products Corp., Tarentum, Pa.

R. Narasimhan, formerly of McGill University, is now with Bloedel, Stewart & Welsh, Port Alberni, B. C.

Roland A. Packard, formerly of Smith Paper Co., is now consulting engineer, Bagley & Sewall Co., Watertown, N. Y.

Alfred R. Phillips, formerly of the Mead Corporation, is now a partner in a construction and logging business in Waynesville, N. C.

R. W. Polderman, formerly assistant plant engineer, St. Regis Paper Co., is now with the Kalamazoo Paper Co., Kalamazoo, Mich.

Simon Posen, formerly with Rayonier, Inc., is now production development and sales manager, Gilman Paper Co., 630 Fifth Ave., New York, N. Y.

Sven Quist, formerly of the Powell River Co., is now with Beecher & Sandwell, consulting engineers, Vancouver, B. C.

Frank W. Roberts is now chief engineer, S. D. Warren Co., Cumberland Mills, Me.

O. K. Ronning, formerly of the New York State College of Forestry, is now with the Union Paper Co., Skien, Norway.

Robert G. Sands is now chief engineer, Carrier Ross Engineering Co., Ltd., London, England.

Norman G. Sixt, formerly with Susquehanna Chemicals Corp., is now process engineer, Carborundum Co., Delevan, N. Y.

S. C. Slifkin, formerly of Ozalid Div., General Aniline & Film Co., is now vice-president, Tecnifax Corp., Holyoke, Mass.

M. F. Smith, formerly of the Simpson Logging Co., is now technical director, Sidney Roofing & Paper Co., Ltd., Victoria, B. C.

Claire Turner, formerly of Warrensburg Pulp & Paper Co., is now paper mill manager, Waterproof-Ohio Div., Pollock Paper Corp., Columbus, Ohio.

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minimize the loss of digester volume due to space occupied.

be readily installed in existing digester shells

prove resistant to all types of corrosion encountered under varying cooking conditions

place no limitation on operating procedure

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Write department "C" for more complete information on the advantages of this 3" carbon brick lining.

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Staley's technical staff, equipment and products are at your service . . . Tell us your requirements and we can recommend the exact Staley Paper Mill Starch for your needs.

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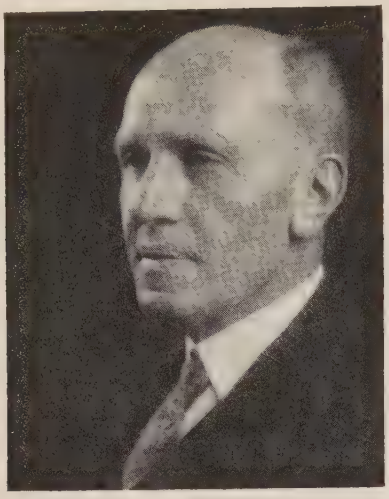
H. R. Wheeler, Jr., formerly chemist of the Oswego Falls Corp., is now with the Rochester Paper Co., Rochester, Mich.

Albert P. Yundt, formerly of the Institute of Paper Chemistry, is now with the Camp Mfg. Co., Franklin, Va.

James Gallatin has succeeded Peter Volanakis as Official representative of the Strathmore Paper Co. in the Technical Association.



William G. MacNaughton (Vice-President 1915–16; President 1917; Secretary-Treasurer 1922–27)

William G. MacNaughton, Engineer of the News Print Service Bureau, New York, N. Y., died at his home in Yonkers, N. Y., of a heart ailment on February 5.

In 1946 Mr. MacNaughton received the gold medal of the Technical Association of the Pulp and Paper Industry for outstanding contributions to the industry.

From 1933 to 1936 he was assistant director of the Savannah Pulp and Paper Laboratory, established by the late Dr. Charles H. Herty for the investigation of the possibilities of Southern pine for white papers, particularly newsprint.

In addition to extending knowledge of the papermaking resources of the Southern states, his investigation resulted in the establishment in 1938 of a newsprint mill at Lufkin, Tex.

Born on a farm in Hinchinbrooke, Huntingdon County, Que., Mr. MacNaughton attended the local country school and Huntingdon Academy. After teaching school for three years, the last two as principle of Shawville Academy in Quebec, he entered McGill University in 1897.

He was graduated in 1901 with a B.A. degree first class honors and the Sir William E. Logan Gold Medal in Natural Sciences.

In 1902 he began his professional career with the Canada Paper Company at Windsor Mills, Que. Two years later, after receiving a B.S. in chemistry, he took a position as chemist for the Canadian Rubber Company in Montreal, remaining until 1908 when he entered the paper industry as chemist for the Nekoosa-Edwards Paper Company. Later he was supervisor of the pulp and paper mill of that company.

During this period he helped found the Technical Association of the Pulp and Paper Industry and was a member of the advisory committee of the Groundwood Research Laboratory of Forest Products that had been established at Wausau, Wis.

From 1917 to 1920 Mr. MacNaughton was vice-president and manager of the Inland Empire Paper Company at Spokane, Wash. For a brief period in 1920–21 he served at Kapuskasing, Ont., during the development of the Spruce Falls Paper and Power Company. In the latter year he was named secretary of the Technical Association of the Pulp and Paper industry with which he remained until 1927 when he joined the News Print Service Bureau as engineer.

From 1929 to 1933 he was associated with the International Paper Company in the manufacturing department, New York. With the completion of his work at Savannah in 1936 he returned to the News Print Service Bureau as engineer.

Mr. MacNaughton had visited most of the pulp and paper mills of this continent, as well as those in England, Norway, and Sweden.

He leaves two sons, William G., Jr., and Peter L.; two daughters, Anne Elizabeth and Mrs. D. S. Hubert; two brothers, Francis and Malcolm MacNaughton; five sisters, and six grandchildren.

RECENT BOOKS

Standards of the Hydraulic Institute. Paper cover, loose-leaf, $8^1/_2 \times 11$, 82 pages, tables, graphs, illustrations, 8th Ed. Published by the Hydraulic Institute, 90 West Street, New York 6, N. Y., $3.

This edition, a revision of earlier issues, consists of six sections: General, Data, Centrifugal Pumps, Rotary Pumps, Reciprocating Pumps, and a new section containing tentative standards on pipe friction.

Each standard code refers to the following: Nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, quality, rating, testing, and service for which designed.

Ed. Note: Although reference is made to friction of paper stock in cast iron pipe, the limitations of the data provided is admitted. At the Third Engineering Conference of the Pulp and Paper Industry sponsored by the TAPPI Engineering Division at Buffalo, N. Y., on October 29th, this as well as much other data on the subject of stock friction in pipes was discussed. As a result an Hydraulic Subcommittee of the TAPPI Engineering Research and Machine Design Committee was organized with K. G. MacKenzie, superintendent of the paper mills, Eastman Kodak Co., Rochester, N. Y., as chairman. This committee will study the subject and will endeavor to work out a method of establishing reliable data for pumping woodpulp and paper stocks. Many offers of assistance by the leading pump manufacturers were offered. Considerable time and effort will be required to resolve this important problem. The problem is intimately related to the power consumption required in pumping stocks of various consistencies and conditions.

An Introduction to Color. By Ralph M. Evans, Head of the Color Control Department, Eastman Kodak Co., John Wiley & Sons, New York, Chapman & Hall, Ltd., London, 1948. Cloth, $7 \times 9^1/_2$ 340 pages, 304 illustrations, and 15 color plates. $6.

Among the subjects covered are: Color and light, light sources, illumination, colored objects, color vision, visual variables of color, perception and illusion, measurement of color, color differences and color names, specifications of color, effects of illuminants, paints and pigments, bibliographs.

It is a completely nonmathematical test and does not presuppose the reader to have a previous knowledge of psychology beyond the first principles. It is, however, not an elementary text since all the necessary concepts are introduced. This book approaches the subject of color from more angles than any previously published.

Copies may be purchased through the Book Department of the Technical Association of the Pulp and Paper Industry, 122 East 42nd Street, New York 17, N. Y.

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TAPPI DIVISIONS AND COMMITTEES

Recent Reports of Activities

Report of Standards Committee for 1948

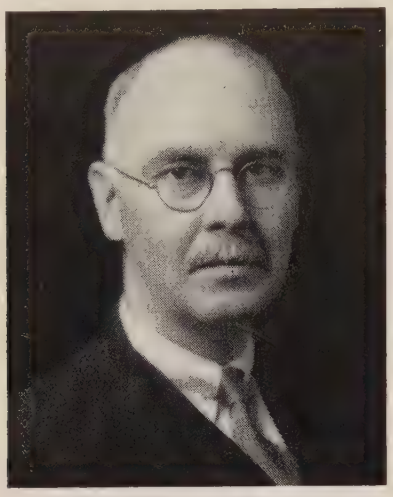

Photo by Blank-Stoller

Roger C. Griffin

While it might at first sight seem anomalous to consider the Testing Division meeting held at Pittsburgh in October the outstanding event in the TAPPI field of standards during 1948, the potentialities of that pioneering event for leavening and improving the Association's standards are very great. Conversely, the interests of the progenitors of TAPPI standards, the committeemen, were so absorbed in that meeting that the year's production of new and revised standards was numerically below par. This probably is all to the good, however, as it is well at times to take inventory of what has been done and where we are going. The results of the Pittsburgh meeting, if followed through, should result in both new standards and improvements in existing ones in the near future.

New and Revised Standards

Three new tentative standards were approved during the year and submitted to the Secretary for publication:

E 602s-48. Specification for Chemical Composition of Process Water for Manufacture of Groundwood Papers (*1*)
O 405p-48. Standard Terms Relating to Tall Oil (*2*)
O 406p-48. Standard Terms Used in the Sulphite Pulping Process (*3*)

One new suggested method was approved and published:

T 479sm-48. Printing Smoothness of Paper (*4*)

One tentative standard, T 460m-46, Air Resistance of Paper, was approved for advancement to an official standard by the committee and will be submitted to letter ballot of the Association.

The votes of the TAPPI membership on the tentative standards submitted for advancement to official late in 1947 were carefully reviewed. The following twelve were accepted as official standards:

T 15m-48. Ash in Wood
T 217m-48. Brightness of Pulp
T 218m-48. Forming Hand Sheets for Optical Tests of Pulp
T 219m-48. Bleach Requirement of Pulp
T 223m-48. Pentosans in Pulp
T 452m-48. Brightness of Paper
T 453m-48. Heat Test for Relative Stability of Paper
T 458m-48. Surface Wettability of Paper (Angle-of-Contact Method)
T 461m-48. Flammability of Treated Paper and Paperboard
T 467m-48. Paraffin Wax Absorptiveness of Paper
T 629m-48. Analysis of Sulphite Waste Liquor
T 630m-48. Melting Point of Paraffin wax

On account of criticisms which were deemed valid, four others were held as tentative standards for further consideration.

Contents of Book of Standards

There were two mailings of methods and standards for the loose-leaf manual. The first was mailed in February and was noted in the 1947 report (*5*). The second mailing, in November, consisted of the following (in addition to new numerical and alphabetical indexes):

5 new tentative standards
1 new suggested method
12 tentative standards advanced to official
1 suggested method advanced to tentative standard
1 revised standard
6 corrected standards

The two mailings contained 47 standards and methods and the manual now comprises the following:

	Tentative	*Official*	*Total*
Standard Recommended Practices	3	10	13
Standard Specifications	3	1	4
Standard Testing Methods	41	109	150
Suggested Methods	..	...	17
			184

Questionnaire on Standards

Last summer a questionnaire was sent to the TAPPI membership by the New York Office at the suggestion of the chairman of the Chemical Methods Committee. The purpose was to obtain data for the Pittsburgh meeting regarding the extent to which TAPPI standards are being used, either "as is" or in modified form, and whether or not they are giving satisfactory results. There were 184 replies received and these may be summarized as follows:

	Number of replies	*% of total*
A. TAPPI Standard Used	6856	77.98
A1. Satisfactory	6031	68.60
A2. Fair	665	7.56
A3. Unsatisfactory	160	1.82
B. TAPPI Standard Used with modification	1115	12.68
B1. Satisfactory	793	9.02
B2. Fair	315	3.59
B3. Unsatisfactory	7	0.08
C. Other Method Used	821	9.34
C1. Satisfactory	583	6.63
C2. Fair	210	2.39
C3. Unsatisfactory	28	0.32
	8792	100.00

The "number of replies" refers to the total number of standards marked in the replies of all returns received. In other words, 184 individuals marked their returns for an average of 48 standards each.

There were 52 individuals who reported one or more standards as "unsatisfactory," but these amounted to only 1.8% of the total. On the other hand, 76% of the replies

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indicated the TAPPI standards were "satisfactory" or "fair" and an additional 13% used modified TAPPI standards with satisfactory or fair results. An additional 9% of the replies indicated methods other than TAPPI standards were found satisfactory or fair. These figures are bare statistics and while they would appear to indicate that TAPPI standards are on the whole at least reasonably good, the brickbats could be of more ultimate value than the bouquets. Having gone this far, it would seem important for the various committee chairmen to contact each of the 52 individuals who cast one or more blackballs, for definite information as to their specific criticisms. This is only fair to those who took the trouble to answer the lengthy questionnaire. It also is the only means of learning, from the questionnaire, whether a given standard has fundamental faults or whether the objection is due, for example, to personal preference for a faster but less accurate method or for a different type of testing instrument.

25 Years of TAPPI Standards

The oldest date on any TAPPI standard in the loose-leaf manual is 1923. This would appear to make 1948 their twenty-fifth anniversary. Table I is therefore attached as of interest to show the yearly growth of TAPPI standards and methods in the past 25 years. The 211 corrections reflect the extent to which standards have been republished to bring them into standard form or to correct mistakes or make other minor changes.

Table I. Growth of TAPPI Standards and Methods

Year	*New TS*	*New OS*[a]	*New SM*	*TS advanced to OS*	*SM advanced to TS*	*Revisions*	*Corrections*
1923	1						
1924	..	..	..	1			
1925							
1926	2	21					
1927	..	1	..	1			
1928	1	..	..	1	..	1	1
1929							
1930	6	..	..	1	..	3	
1931	7	..	..	3			
1932	27	..	..	4	..	2	
1933[b]	8	..	..	24	..	4	1
1934	3	..	..	11	..	5	9
1935	4	..	..	5	..	8	19
1936	4	..	2	2	..	5	23
1937	4		2	4	1	..	6
1938	3	..	..	1	..	3	
1939	1	..	2	2	1	5	
1940	5	..	3	4	..	4	17
1941	2	..	3	5	..	6	13
1942	13	..	1	5	1	11	7
1943	8	..	4	3	..	11	2
1944	6	..	4	5	..	7	36
1945	7	..	1	4	1	2	48
1946	6	..	7	5	..	3	10
1947	3	..	..	..	7	2	13
1948	4	..	1	12	..	..	6
	125	22	30	103	11	82	211

[a] There appears to be no record of when these 22 official standards were first issued as tentative standards.
[b] Standards Committee organized.

TS = Tentative Standards; OS = Official Standards; SM = Suggested Methods.

LITERATURE CITED

1. *Paper Trade J.* 126, No. 9: 105 (Feb. 26, 1948).
2. *Paper Trade J.* 126, No. 21: 54 (May 20, 1948).
3. *Paper Trade J.* 127, No. 9: 60 (Aug. 26, 1948).
4. *Paper Trade J.* 126, No. 16: 62 (April 15, 1948).
5. *Paper Trade J.* 126, No. 23: 59 (June 3, 1948).

ROGER C. GRIFFIN, *Chairman*
TAPPI Standards Committee

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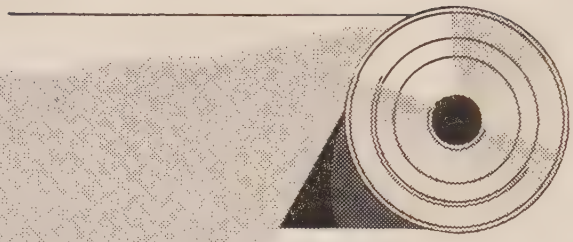

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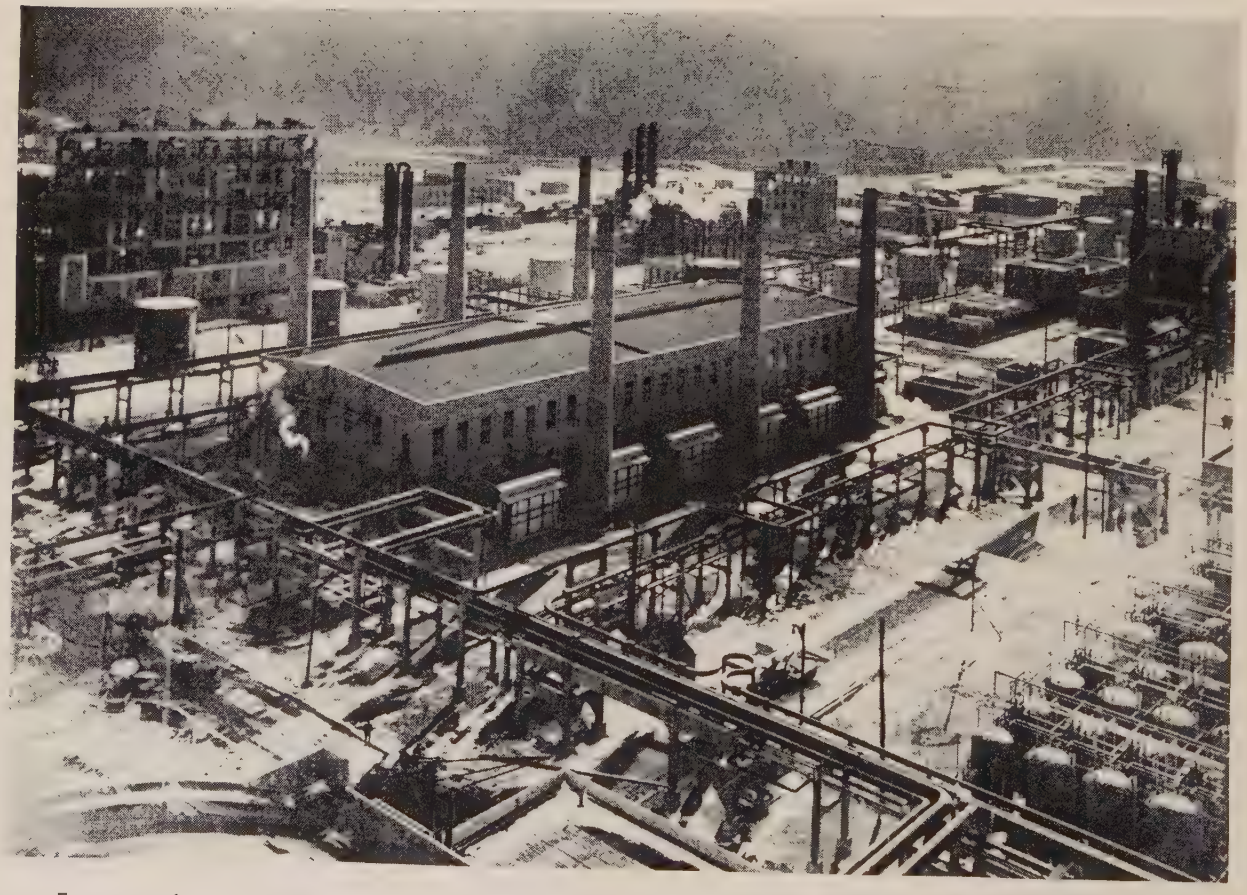

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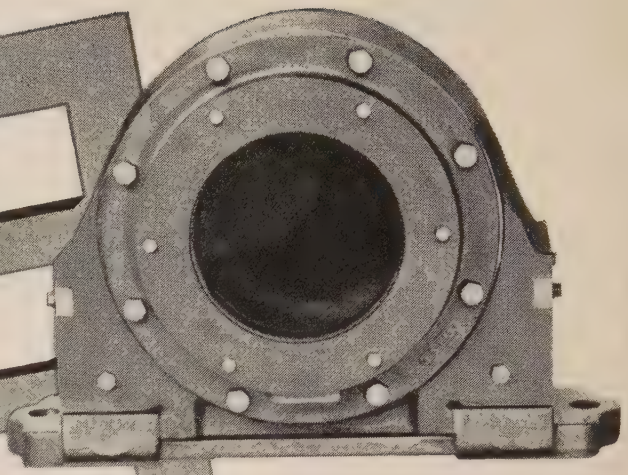

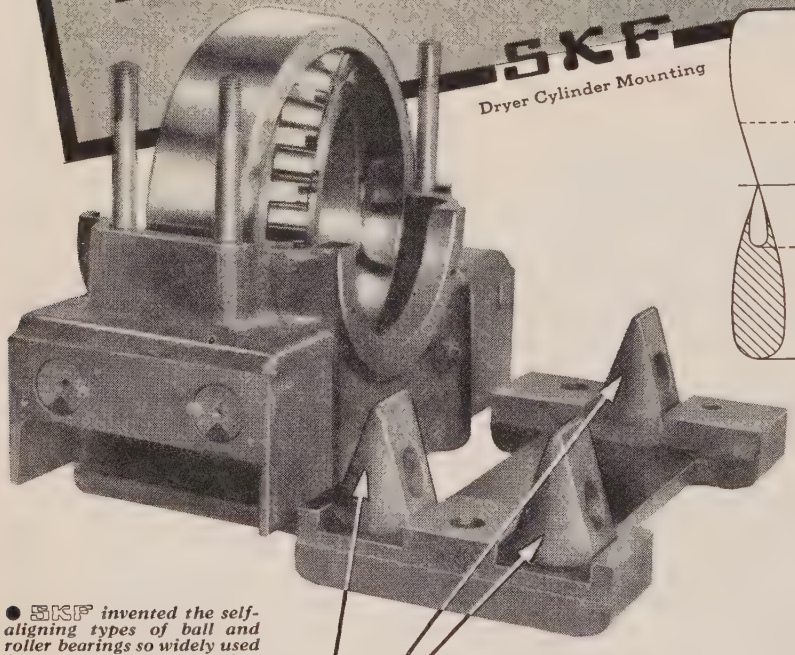

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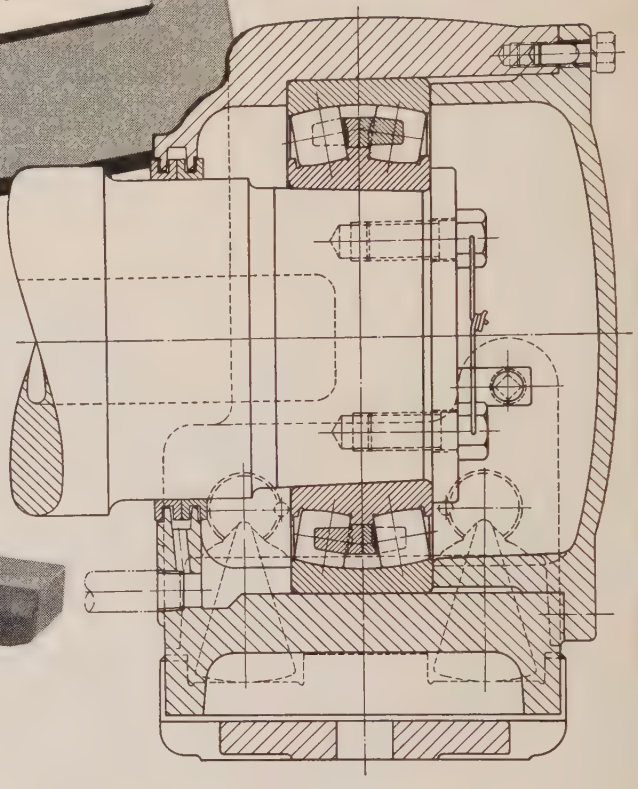

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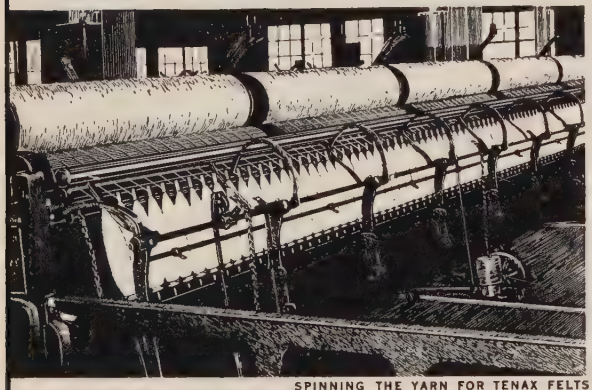

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Calendar of TAPPI Meetings

NATIONAL

Paper Coating Conference, Pantlind Hotel, Grand Rapids, Mich., April 26–27, 1949.

General Fall Meeting, Multnomah Hotel, Portland, Ore., September 11–15, 1949.

Fourth Engineering Conference of the Pulp and Paper Industry, Statler Hotel, Boston, Mass., October 31, November 1–3, 1949.

LOCAL SECTIONS

CHICAGO SECTION: Chicago Bar Association, Chicago, Ill.
March 21, 1949; April 18, 1949.

DELAWARE VALLEY SECTION: Engineers Club, Philadelphia, Pa.
March 24, 1949—"Recent Progress in Cellulose Research," by Herman Mark, Polytechnic Institute of Brooklyn.
April 28, 1949—Testing Methods—A Panel Discussion, R. J. Knoll, Scott Paper Co., Moderator.
May 26, 1949—"Long Range View of the Pulp Supply," by James L. Ritchie, U. S. Pulp Producers Association.

EMPIRE STATE SECTION:
Western New York Group: April 13, 1949, at Erie, Pa., sponsored by the Hammermill Paper Co. Tour of mill, followed by dinner meeting.
Metropolitan Group: Fraunces Tavern, New York City.
Meetings on first Tuesday of month.

KALAMAZOO VALLEY SECTION: Park American and Columbia Hotels, Kalamazoo, Mich.
Meetings on second Thursday of month.

LAKE STATES SECTION: American Legion Club House, Appleton, Wis.
April 12, 1949—Marathon's Canadian Operations

NEW ENGLAND SECTION:
Meetings usually held on the third Friday each month, usually at the Roger Smith Hotel, Holyoke, Mass., unless otherwise announced.

OHIO SECTION: Manchester Hotel, Middletown, Ohio

PACIFIC SECTION:
April 12, 1949, Longview, Wash.—Shibley Award Contest

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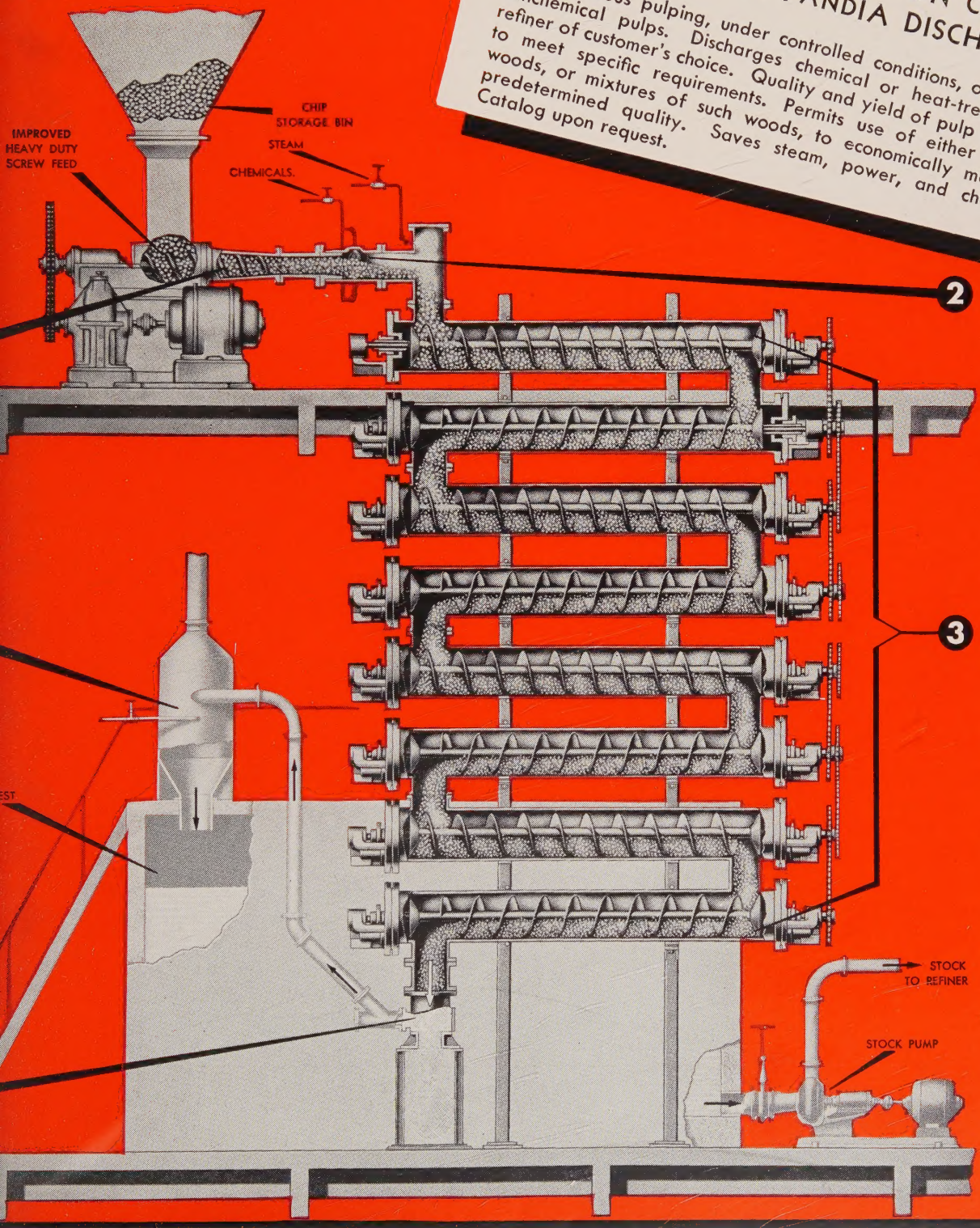

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